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BRITISH MANUFACTURES AND THE POLICY OF UNFETTERED COMMERCE.

By Edward Atkinson, LL. D., Ph. D.

With British manufacturers beginning to talk of governmental protection against foreign competition, and with American manufacturers, in rapidly increasing numbers, already agitating for a reduction of tariff duties, especially upon raw materials, it seems high time for thoughtful consideration of the subject. For at bottom the tariff question everywhere is a matter of plain business, and must ultimately be settled through the active influence of business men acting for business reasons and entirely apart from politics. We are especially pleased, therefore, in being able to present two timely and notable discussions of the subject—the first by Mr. Edward Atkinson, who stands in the front rank of American economists and who writes from New England, the home of the American protective system; and the second by Mr. William L. Saunders, who is prominent in the American National Association of Manufacturers, and who, as vice-president and general manager of a great engineering firm doing business with all the world from London and Melbourne, as well as New York, writes as a business man without regard to political or partisan considerations.—THE EDITORS.

IN a recent address by Lord Rosebery at the annual meeting of the Wolverhampton Chamber of Commerce he used one expression which is very surprising, coming as it does from one who is the potential leader of the liberal party of the United Kingdom. He said "the war he feared (in the future) was not a military war, but the war of trade which was inevitable. * * * There were two nations which were obviously our rivals and opponents in this commercial war, America and Germany." The use of the word "war" in this connection is much to be regretted. It is probable that Lord Rosebery used it unthinkingly. It is wholly inconsistent with the fundamental principle and conception

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of the policy of free trade. The idea which it represents is but a survival of the mediaeval theory that in international commerce or trade what one State or nation gains another must lose. This false conception of commerce has retarded the progress of the world and has been the cause of more criminal aggression of one country upon another than any other fallacy that ever misled the human mind. This same delusion brought about the separation of the Colonies of America from the mother country, which Lord Rosebery so deplores. If the use of the word "war" were fit or proper in dealing with international trade, it would bar the way to the future re-union of the English-speaking people, not in government, but in reciprocal commerce, in pursuance of their mutual interests and interdependence, which Lord Rosebery so earnestly seeks. There have been, there are now, and there may for a short time continue to be, wars of tariffs; but a war of trade is unthinkable to any one who has a true conception of the benefits of commerce and of the principles which governed Peel, Gladstone, Bright and Cobden in the adjustment of the British revenue systems in such a manner as to open wide the doors of Great Britain to all the commerce of the world. And yet the term "British free trade" is not fully warranted. Englishmen have no title to arrogate it solely to themselves. The Netherlands anticipated Great Britain by two centuries or more, conducting their long struggle with Spain on a free-trade basis, emerging from it rich and prosperous, the rival of England on the sea and the peer of any nation in commerce, while Spain entered upon her period of decadence for the very reason that her rulers were actuated by the same fallacies that Lord Rosebery unthinkingly admits when he uses the phrase "a war of trade."

Another fact has almost escaped attention. The prosperity of the United States, the diversity of their industries, the growth of their mining, metallurgy and manufactures, and the vast development of their agriculture, are due to the American system of almost continental free trade, such as never existed over so great an area before and such as has never been enjoyed by so large a number of people. In fact, free trade among the States is the bond that keeps the nation in existence. The war of tariffs between the Confederated States after the treaty of peace in 1783, and before the adoption of the constitution in 1789, led to actual warfare on a small scale between New York and Connecticut. These wars of tariffs between the States nearly caused the disruption of the union. American free trade on a continental scale had fully justified itself half a century before the British protective system culminated in disaster in 1840.

To what desperate straits the British nation had been brought by the policy of protection is witnessed by the words of Sir Robert Peel when he described the conditions in which he found her trade, commerce, and manufactures in 1840. He attributes these adverse conditions to the efforts that had been made to develop and protect the home market and to prevent other nations from supplying the wants of the people. This was the result of legislation governed by the fallacy of a "war of trade." I may quote from memory some extracts from Peel's speeches. In one he said, substantially in these words, "What conditions do we now witness? Our ships rotting at the wharves; our manufacturing population rioting in the streets; our agricultural population starving in the fields; the Chancellor of the Exchequer seated on an empty chest, over the pool of a bottomless deficiency, fishing for a budget. * * * The policy which we have adopted and continued for the purpose of developing and retaining the home market has almost destroyed that market by reducing the great mass of the population to beggary, destitution, and want."

The American system of free trade on a continental scale, coupled with slight dependence on foreign countries for any of the necessaries of life and for few of the materials used in manufactures, has prevented any such generally adverse conditions in the United States; but there are arts, notably the wool and woolen trade at the present time, in which the adverse conditions due to a bad tariff closely correspond to those pictured in Peel's speeches.

I may venture upon a little personal reminiscence at this point. On one of my visits to London when Mr. Gladstone was Prime Minister and at the height of his power I was a guest of the Economy Club at a meeting where the late Professor Sidgwick was announced to read a paper on "Some exceptions to the Application of the Principle of Free Trade." We had taken our seats, myself at the right of the chairman, Mr. G. J. Shaw Lefevre, as the guest of the evening, when Mr. Gladstone appeared, for the first time in seven years at a meeting of the club, doubtless attracted by the title of the paper. Professor Sidgwick took the ground closely corresponding to that of John Stuart Mill, and also to Alexander Hamilton's theory of protection from which we have so widely departed, namely: that certain industries which are deemed of national importance, like iron and textiles, may be rightly aided by government in their early period. Mr. Gladstone responded indirectly by giving a half-hour of most interesting reminiscences of the great contest from the time of Huskisson in

1824 to the close of the matter under himself in 1856. To my dismay I was next asked as "the stranger" to give my views. I was called upon to think quickly, and I decided to astound my hearers by direct denial of Professor Sidgwick's thesis, basing my denial wholly upon the experience of the United States. The words which I then spoke would be fitting words in this discussion.

"Mr. Sidgwick holds that the success of certain important branches of manufacture which are in their infancy may rightly depend on temporary protection granted by the government. I shall disprove this theory by stating facts derived from the experience of the United States of America." I paused a moment to observe the shock of surprise that went around the table, and then said, "You will bear in mind that for nearly a century, since the adoption of our constitution, the benefit of absolute free trade has been enjoyed in the United States over a wider area and among a greater number of people than ever before were permitted the privilege of free commerce in the history of the world. This area is endowed with greater internal resources and possesses a more varied climate, from almost tropical to almost frigid, than any other great single State with the possible exception of Russia. The systems of law vary from the Roman law established in Louisiana to the common law of England in Massachusetts. The methods of local taxation are very different. These variations among the States, coupled with as great variation in race, color, and condition of the inhabitants, exceed the differences which prevail among the several states of Europe; yet compulsory free trade has been the bond of union among them and has made their interdependence the vital fact in their history, notwithstanding the fact that over almost half our settled territory the theory of protection or privation of liberty was carried to its logical end in the internal affairs of the States themselves. Until 1865 the employer of labor not only directed the laborer, but he owned him. Under that condition these States were subjected to the evil which the advocate of protection holds out as the necessary result of free commerce. The southern slave-stricken community was devoted almost exclusively to agriculture. There was little or no development of manufactures except in home-spun fabrics. There were few or no mechanics except the slave blacksmiths and carpenters bred on the great plantations. That system culminated in the civil war by which slavery destroyed itself. The southern States were then left without capital. The wealth which had been inherited had nearly all been taken away by the emancipation of the slaves. The railroad system

was destroyed. There was no inherited aptitude among the whites for the manufacturing arts, for mechanic arts, or for mining. But these States were subject to the absolutely free competition of the great iron works of Pennsylvania, the huge textile factories of New England, and the wood-working shops of the great west and north.

Little more than half a generation has elapsed since the infant industries of the new south were undertaken. What are the present conditions? (This was, I think, in the year 1893.) Pennsylvania striving by the adoption of every possible improved method to meet the competition of the iron furnaces of Alabama. New England trembling lest the center of the textile arts shall be moved from Massachusetts and Rhode Island to the Carolinas and Georgia. The wood-working shops of the middle south competing with the great establishments in the middle west. I think I need make no further rejoinder to Professor Sidgwick's plea for even temporary protection to infant industries. Let these facts speak for themselves." There was little further discussion at that meeting.

I cite this incident because of its application to the present conditions of the United States and the United Kingdom. Can there be a "war of trade" between the two great branches of the English-speaking people in their effort to supply each other's wants in the peaceful commerce which is annually increasing in volume and importance? Can there be a "war of trade" between the United States and Germany or France, even though there is now a war of tariffs between them? It will be observed that the United States, the United Kingdom of Great Britain and Ireland, Germany, France, and Belgium are the only States to which the rest of the world can look for the principal supply of the wants of the people with the products of the mill, the mine, the furnace, and the workshop. Their population numbers in round figures 220,000,000. The computed population of the world numbers 1,500,000,000. Is there not room for the work of all the manufacturing States in supplying the increasing wants of the non-manufacturing continents, islands, and countries which are now being so rapidly developed by the railway and the steamship? Was there any "war of trade between the northern and southern iron and textile masters of the United States? Far from it. They rivaled each other in the exchange of services, each section supplying the other not only with machinery, but with the ideas and rules governing production and the men capable of putting them into practice. Presently they began to exchange products. The crude iron was sent from Alabama to Pittsburgh to be converted into machinery. The gray cloth was sent

from the southern mills to Massachusetts and Rhode Island to be bleached and printed. In this mutual service and in the stimulus to improvement is to be found the key to the rapid extension of American exports to other countries. How would it have been had obstructions been put in the way of service between the States, and had the effort been made to promote the arts in each of these sections by the bounties and subsidies of the protective system, each section cut off by a war of tariffs in place of each striving to gain skill and thereby to reduce the cost of labor? This development has been accomplished not by oppression of the laborer, but by advancing the rates of wages under the necessary competition which governs wages, the efforts of capitalists to secure the highest skill. Under this influence rates of wages have been carried to the highest point ever attained in the United States or any other country, while the cost of labor in each unit of product has been reduced to the lowest point.

What stands in the way of similar benefits being exchanged between the five great manufacturing States or nations of the world that I have previously named, except the existing war of tariffs, which has been generated in the false idea that there can be a "war of trade," to which Lord Rosebery has given such unthinking expression? It may not be denied that under a zollverein or substantially free system of trade, new adjustments of the different branches of industry of the manufacturing States and nations of the world would be made. In fact, under existing conditions they must be made. This readjustment cannot be brought about without a good deal of difficulty and some special personal disaster, especially in Great Britain. The far-sighted thinking men of Great Britain have long foreseen the supremacy of the United States in the production of coal and iron. They have long been aware of the consequent transfer of the dominion of steel to that country, and they have been warned that the paramount control of the great commerce of the world would pass to the United States with this paramount production of steel whenever the United States ended the war of tariffs and removed the obstructions of their own system, especially by taking off the taxes from the crude products of Asia, Australia, Africa, and South America. America once nearly gained the leading position with her fleet of wooden ships, built at high wages and low cost by the application of science and skill to that art. She will resume that position in the construction of a fleet of steel whenever she removes the obstruction of her navigation laws, which have driven her flag from the commerce of the ocean.

Before dealing with this paramount factor in commerce, the control

of steel, one may be permitted to remark that although two of the wisest addresses have been made by the Right Honorable George J. Goschen on "The Imagination a Potent Factor in Commerce," Britons are, as a rule, somewhat deficient in that faculty. The supremacy of Great Britain in commerce and manufactures, since the adoption of the free-trade policy and the repeal of the navigation acts, has been so complete and absolute as to have prevented Englishmen, with few exceptions, even imagining that with the progress of science and invention in their special application to coal, iron, and steel their paramount position could ever be endangered. Although Jevons had warned them thirty years ago of the danger of an increasing cost of coal;* although Gladstone long since foresaw the adoption by the United States either of free-trade or a low tariff policy, and the extension of American commerce which would surely ensue in urgent competition with British goods; although Cobden, Bright, and Gladstone worked earnestly to keep the peace and to pay the national debt in preparation for American competition; although Lowthian Bell pronounced the deposits of iron ore in close proximity to coal in Alabama to be the "imperial deposits" of the world, when scarcely a mine had been opened—it had not entered the imagination of the average Englishman, and especially of the British workman, until very recently, that the supremacy of the United Kingdom in manufactures and commerce could ever be imperilled. Even though Cobden and Bright knew better, their supporters of the so-called Manchester School never imagined existing conditions! They believed the United States to be a great farm and forest from which Great Britain might secure food, fibres, and timber. They thought the two nations were complements of each other and that they might exchange products to the benefit of both, the one supplying the other with the products of agriculture the other returning manufactured goods. It did not occur to them that the conditions and character of the people of the United States rendered it certain that manufacturing and mechanic arts would surely develop in due proportion to the extension of agriculture. This rule has been made plain in the development of the country. Where there is but little good land and where the climate renders indoor work desirable, as in

* The next discovery of science may be the success of one of the many undertakings to convert coal into electric energy without the enormous waste of the present practice in steam engines and boilers. When that discovery is made it portends another industrial revolution. It would not, however, greatly change the relative power of countries according to their supply of iron ores suitable for making steel. The next subsequent great invention may be one which will render the choice of ores for steel-making unimportant, by rendering the separation of injurious elements a matter of simple and common practice.

New England, the proportion of the population occupied in the manufacturing and mechanic arts is large,—the proportion in agriculture is small,—but in all other parts of the country the manufacturing and mechanic arts have developed in regular sequence and proportion. Wherever deposits of iron ore were found in the colonies, when iron was made with charcoal, the iron and steel industries were established within twenty years from the date of the first settlement, either by the colony or subsequently by the State. Wherever iron or coal have been found in any of the States subsequently to the smelting of iron with coal, the iron industry has established itself irrespective of tariffs or of any other condition than the immediate needs of the neighborhood.

Nearly every important art had passed or was passing through its infant stage before any tariff had been enacted by the United States. In Alexander Hamilton's notable report, when he first proposed a slight protection to infant industry, the list of manufactures already "successfully established" covers every one of the existing arts, which have since been clamorous for protection, except those due to subsequent invention. Even in respect to cotton, the manufacture was already established before the invention of the cotton gin, and Hamilton proposed a repeal of the tariff tax of three cents a pound on India cotton in order to promote an industry already successfully begun. It is due either to the lack of imagination or to over-confidence resulting from the long supremacy of the British in manufactures and commerce that, when the new conditions are suddenly brought before them, there is an expression of alarmed surprise at the rapid extension of exports from the United States. This great extension of exports did not take place until the disparity which American duties on pig iron had caused in the price of iron to home consumers, as compared to those of Great Britain, had disappeared. In 1890-91 the vast iron and coal resources of the United States had been developed. This brought about home competition among American iron furnaces with the effect of bringing the price of iron and steel to the level of British prices, and soon to a lower level. All that had prevented the construction of ocean steamships, of heavy machinery, tools, and other metallic products for export had been the disparity in the price of iron. The United States' tariff had so long protected the iron masters of the United Kingdom that it does not seem to have occurred to them that America would ultimately be enabled to make iron and steel at a less cost, even though paying very much higher wages. The coal mines of the United States being upon the surface, readily worked, and the iron mines either in actual proximity or brought into close proximity by the low

rates charged on the railways, justify high wages and low cost of production. The output of iron per man lately disclosed in official figures brings this point into conspicuous notice. The real effect of the duties on iron imposed by the United States during ten years from 1880 to 1889 was to protect the metal workers of Europe in their control of all other markets, in the supply of machinery, tools, engines, and even in part meeting the demand of the United States, at the same time building up the great fortunes of American iron and steel makers. The increase in the price of crude iron to the metal users of the United States, as compared to the price charged to the consumers of British iron, was $7 per ton, on an average consumption of iron in the United States of 10,000,000 tons a year. The cost of protection to iron in the ten years was $700,000,000—a bounty more than equal to the value of all the iron furnaces, rolling mills, and steel works in the United States in 1891.

All these conditions are now changed. The United States have become independent in respect to all metals except tin; in respect to fibres with the exception of silk and flax, since it is now evident that if the duties which have brought about very adverse conditions in the wool and woolen industry were wholly removed, the demand for American wool would be vastly greater, a free supply of all the wools of the world in order to make suitable combinations being absolutely necessary to the success of the woolen and worsted manufacture taken as a whole. The United States are independent of all other countries in food, timber, fuel, ores, and nearly every necessary article that enters into the products of domestic industry. On the other hand, Great Britain, France, and Germany, the great manufacturing states of Europe, have become largely dependent upon America for food, fibres, timber, and fabrics of many kinds. Perhaps that list will soon include coal and crude iron and steel, although it is not desirable on the part of the United States that they should become great exporters of coal, even though they have such an abundance. The exports of the country mainly consist of the surplus products which are not needed and which could not be consumed, all having enough; while the exports of Great Britain, France, and Germany consist mainly of goods and wares which they must sell in order to obtain means of buying the very necessaries of life and the crude materials of foreign origin without which their manufactures could not have attained their present stage.

The huge traffic between Great Britain and the United States proves how close the trade alliance for the mutual benefit must of necessity hereafter be between the two branches of the English-speak-

ing people. The figures of the export from the United States, compared with the import figures of the continental States of Europe, show how absurd the project is of the great land-holders, called Agrarians, and other privileged classes in Germany to join in a tariff war against the cheap labor of America—not the pauper labor, but the highly-paid labor. Success in the effort to boycott the food, fibres, and fabrics of the United States by heavy taxes imposed under a tariff war would endanger all the manufacturing industry of Germany by increasing its cost, while at the same time if it had any effect in the United States it would be to reduce the cost of food and crude materials to home manufacturers, and thus enable them to take the control of all the great markets of the world outside of Europe, of which they have as yet only taken a moderate share. The lesson which Germany and France have yet to learn is the one that Great Britain learned fifty years since and that the people of the United States are now so rapidly mastering; namely, *that a tariff war on foreign imports is the greatest possible obstruction to the exports of domestic products.* For more than fifty years the relatively high wages of Great Britain, as compared to those of the continental States, and the low cost of her labor due to skill and invention, have enabled her to dominate the commerce of the world. America is bound to share in larger and larger measure in that commerce as time goes on. The people of the United States are rapidly learning that there is nothing so dear as the so-called pauper or unskilled labor of other continents; nothing so cheap as the highly-paid workmen who are competent to operate modern mechanism. That State which possesses the greatest abundance of fertile land, of timber, of ore, and of coal, may with half the labor required under other conditions, measured by hours or physical energy, secure double the product of the less capable or less well-endowed workmen of other lands. If the rate of wages or earnings of the workmen of a country governed and established the cost of labor in the product, not one dollar's worth of exports could pass out from American harbors. There is not a single article exported, cotton or corn, ore or metal, machine or fabric of any kind, in which the wages or earnings which are recovered by the American workmen from the sale of these exportable products are not from 25 to 50 per cent. above the corresponding wages or earnings of the mechanics or artizans of Europe, or from ten to twenty times as much as the earnings of the peasants of Egypt, India, or China, who grow cotton and corn in competition with the Western Continent.

It is strange but true that the invention of an Englishman, Sir

Henry Bessemer, made the lessening charge possible for transporting the wheat of the Mississippi Valley to Great Britain, the effect being to deprive the English landlord of a large share of his rents and to render a readjustment of English and Irish tenures absolutely necessary to the further progress of British agriculture. Again, the joint invention of two other Englishmen, Gilchrist and Thomas, enabled Germany to convert her phosphoric ores of iron, previously of little use or value, into steel; and on that foundation her whole advance in the export of manufactures has been developed.

All that has thus far been said might seem to justify Lord Rosebery's phrase of "war of trade", but there is another aspect of the problem which remains to be considered. The proportion of the working population of the United States which is employed in any art of which a product of like kind could be imported in any important measure is very small, not 5 per cent. of all who are occupied for gain. Since American supremacy in iron was established there is practically nothing produced from the mines of the United States of which any corresponding product could be imported which would compete. America needs the ores of Cuba and Canada to mix with her own at the sea-coast furnaces. The textile arts and a very few other branches of industry are the only ones which would be subjected to any important change by an abatement of protective duties. If the materials of foreign origin which are necessary for the best use of the domestic products in the textile arts were admitted to the United States free of duty, the only import of similar fabrics from foreign countries would be of the hand-made fabrics, like laces and the best silks, which are woven on hand looms, or other goods which depend on the changes of fashion and fancy and not on their quality. The admission of the crude and partly-manufactured products which are necessary in the processes of American industry would doubtless enable the textile factories of the country to take a very much larger share in the increasing consumption of the world through exports. The American system of free trade may soon be extended on the methods of common sense, to the gradual but sure removal of all the duties on imports except those which may be maintained for revenue. American free trade will surely be so extended as soon as the country becomes aware of the fact that the worst obstruction to exports is the taxation of goods by duties on the imports, which it might secure in exchange for its products, especially from the great non-machine-using continents.

What proportion of the population is occupied in manufactures in

Great Britain is not within my knowledge. It must be very much larger than in the United States. But in this matter, again, it would doubtless appear upon analysis that the domestic traffic of Great Britain is very much greater than its foreign traffic, and that it may be widely extended. The manufacturing arts of which products are ever imported or exported are very limited in number. There are over three hundred and sixty titles in the United States census listed under the head of "Manufactures." It would be, however, difficult to find sixty, hardly more than thirty, of which any product of like kind could be imported at the present time, and that small proportion gives occupation to not exceeding 10 per cent., perhaps a much less proportion of those who are occupied in these branches of industry which are listed as manufactures. The same rule would be measurably true of the conditions of British manufactures. The lesser manufacturing and mechanic arts are of much greater importance in the building up of a State than are the great factories, mines, and furnaces. They tend to develop individual capacity and aptitude rather than to develop the operative or adjunct to the machine.

May it not, therefore, be held that if the war of tariffs of the United States, France, and Germany could be abated, these countries co-operating in mutual service, the exchanges and the benefits of commerce would vastly increase, each of the great manufacturing States assuming its true position in that kind of work best suited to its soil, climate, and conditions? If, again, Russia, now entering upon her great industrial progress and seeking to throw off the burden of militarism and to join in the establishment of peace, could be brought into this "zollverein," as it might be called, the peace of the world would be assured. The abundant supply of all the wants of mankind in each country would be enhanced; the few privileged classes might have been sacrificed to the benefit of the many; but there would still remain the enormous demand of the rapidly developing continents which have not to any extent become manufacturing or mechanical States, to be supplied. It would be with respect to textiles as it has been with respect to iron and steel. In 1890, when the product of pig iron was in round figures 25,000,000 tons, I predicted that in the year 1900 40,000,000 tons would be required, and that it might be beyond the capacity of the then existing iron furnaces of the United States, Great Britain, and Germany combined to supply that demand. That prophecy was nearly justified. There is now a slight reversal of the demand on the abnormal rise in the value of coal, but at normal prices it is certain that 60,000,000 tons of iron will be in-

sufficient to meet the wants of the world within ten or twenty years as it was that the supply of the year 1899 was barely sufficient.

Once the world is relieved from the blood tax of standing armies and the waste of warfare, the factories, workshops, mines, and furnaces of the five great manufacturing States, the United States, the United Kingdom, France, Germany, and Belgium combined would be insufficient to meet the increasing wants. On the other hand, the removal of obstructive taxes to the import of the crude and partly manufactured materials of the non-machine-using nations would so increase their power of purchase as to enable them to supply these wants.

It will be remarked that the unfortunate and causeless war between the United States and Great Britain in 1812 was fought by the Americans under the motto of "Free Trade and Sailors' Rights." The representatives of certain industries which had been pushed to an unwholesome success during that war and the embargo, then made the first effort to secure the adoption of a tariff based on the single motive of protection. This was resisted by the great merchants of New England, and at a meeting held in August, 1820, a committee of their number, including Nathan Appleton and Abbott Lawrence, who afterward became advocates of protection when they had been forced out of commerce into manufacturing, appointed Daniel Webster as their spokesman. He was then in the fullness of intellectual power. He denounced the effort to name this system an American system. He claimed for America the rights of American free trade. He said that the protection policy was being borrowed from Great Britain at the time when British statesmen were trying to overcome its evils. One paragraph from this great speech may well be quoted at this time:

"To individuals, this policy is as injurious as it is to government. A system of artificial government protection leads the people to too much reliance on government. If left to their own choice of pursuits, they depend on their own skill and their own industry. But if government essentially affects their occupations by its systems of bounties and preferences, it is natural, when in distress, that they should call on government for relief. Hence a perpetual contest, carried on between the different interests of society. Agriculturists taxed to-day to sustain manufacturers—commerce taxed to-morrow to sustain agriculture—and then impositions, perhaps, on both manufactures and agriculture to support commerce. And when government has exhausted its invention in these modes of legislation it finds the result less favorable than the original and natural state and course of things. He could hardly conceive of anything worse than a policy which should place the great interests of his country in hostility to one another—a policy which should keep them in constant conflict, and bring them every year to fight their battles in the committee rooms of the House of Representatives at Washington."

Webster never gave up this principle. He became an advocate of protection, but in his later years he referred to his early declarations as those which were founded on principle and not on policy.

The policy of a tariff for revenue with incidental protection, which was established in the United States by Hamilton, sustained by Webster in his later years, and continued down to a recent period, has been completely changed in recent years to the theory of a tariff for protection with incidental revenue. This latter system has broken down in the house of its friends. The only force by which it is sustained at the present time is the fear of manufacturers that if they advocate the removal of duties on the crude or partly manufactured materials of foreign origin which are necessary in their own branches of industry, they may be subjected to a reduction of the very high duties on their own fabrics without gaining the relief from duties on the materials. The men who made the present system and who forced it upon the leaders in Congress are now divided among themselves, and are bringing about a division in the political parties. It may be hoped that the tariff question will soon cease to be a party measure in America. In that event the reform of the tariff may be accomplished by evolution, not by revolution; duties may be adjusted for revenue purposes, obstructive duties to crude materials entirely abated, and the open door offered to the great continents of Asia, Africa, South America, and Australia, for the free entry of the raw materials of which American manufacturers may make the most profitable use.

The great progress of the English-speaking people has been made in the past by free foreign commerce on the part of the United Kingdom and by American free trade on a continental scale within the United States. The United Kingdom of Great Britain and Ireland, the British colonies, and the British dependencies are now buying from the United States a fraction over fifty (50) per cent. of all the exports of the country. They are America's best customers. In the light of that fact one cannot yet imagine the grand conditions of commerce which will ensue when the English-speaking people shall be fully united by their own interests in mutual service, thus building up industries and insuring the common welfare wherever any branch of the English-speaking people may dwell, however they may slightly differ in their political institutions. When their forces are united for the protection of commerce, for the maintenance of open trade and open ports, no power existing and no union of the dynastic powers of Europe could venture to dispute their righteous and beneficent control.

AMERICAN TARIFF POLICY NOW SHUTTING THE OPEN DOOR.

By W. L. Saunders.

Mr. Saunders' article is a powerful counterpart to the preceding paper by Mr. Atkinson. As one shows how America's wonderful expansion has been based on unfettered internal commerce, the other uses a concrete living instance to show how it will be checked, by protectionist shackles, from the now necessary range abroad. Mr. Saunders makes a forceful plea for the revision of an outgrown system.—THE EDITORS.

AT one time, about 1895-96, there appeared on the surface of things indications of prosperity. The entire world, the United States especially, had passed through a long period of depression, and every one was looking to see a turn towards better times. The writer met the late "Copper King," Mr. Marcus Daly, a self-made American of far-famed ability, and called his attention to this renewal of activity with the idea of getting his opinion on the subject. "Yes," said Mr. Daly, "the wheels of commerce are going around, but who in the devil is going to buy the stuff?"

And so it was. The renewed business was only temporary. The mills had begun to grind, and did produce at an active rate, but a limited market soon consumed the product, and the throttle was applied to the engines, reducing and in many cases stopping the pace. It was not until the latter part of 1897 that prosperity came in earnest, and in 1898 we realized that it had come to stay. This activity in business started first in Germany, antedating the rest of the world by more than one year. Great Britain caught the pace next. Then followed the United States with a longer and more permanent stride.

Prosperity is not a permanent thing. It acts like the ocean wave, now up and now down, subject to many controlling influences. The great and perhaps only barometer which we have to guide us is the iron and steel industry, and Mr. Carnegie has defined that as "either a prince or a pauper." Other lines of industry are subject to the same variations, but to a lesser degree. These conditions are especially apparent in a great manufacturing country, and with America the liability to fluctuate is also influenced by her vast agricultural interests. Twenty-five years ago, bad crops would have surely meant depression

and ruin; but now that the United States has taken its place in the forefront of manufacturing countries, there exists a counter influence to crop dangers—provided there is an outlet other than the home markets for the products of American mills.

A nation that is subject to fluctuations in its business because of crop conditions is less stable than one which depends upon its manufactures. In one case there is no remedy, because we cannot govern the course of nature; the other appears to be within our control. Famines, which in olden times were looked upon as acts of God, and which still occur, are happily confined to agricultural countries only, such as India and Russia. But in the place of famine, manufacturing countries suffer the scourge of business depression, business failures, and financial ruin, just in proportion as the interests of the people are mismanaged. The United States has at several periods fallen a victim to mismanagement, and had it not been for the strength imparted by good crops, which have found markets throughout the world, it is very likely that the sufferings would have been greater. This is because, being an ambitious people, always striving to get rich, we naturally become extravagant, and during good times are "plungers." The danger is also great with us because of our inventive skill. We economize labor wherever we can, and in economizing labor we increase production. An American manufacturer who gets behind in orders does not hesitate to increase his plant, to work overtime, and to put in new machinery—or, in fact, to do anything that will enable him to produce all that he can sell. The stimulus to do this has been very acute during recent months because of the prevailing high prices; and every one is familiar with the frequent notices that have appeared of furnaces starting up, new enterprises, and additions to plants.

Mr. Thomas A. Edison recently completed a machine which he uses to make an important part of his phonograph. In exhibiting this he showed a somewhat complicated steel part, turned and finished, and produced at an expense of a few cents, because the labor employed was a girl who fed a light steel bar to the machine; and, as Mr. Edison said, 99 per cent. of the work is done by machinery. Turning to me he remarked: "It would have been money in my pocket had I never taken out a patent, but instead devoted all my time to the building of labor-saving machinery, because it is easier to get around a patent than it is to compete against a manufacturer who produces everything by machinery. If you have got your cost down to bed-rock you can supply the world's market." It is a well-known fact that the tremendous business built up by Mr. Carnegie is mainly the result of

his enterprise and nerve in cutting down labor, scrapping his plant, no matter what it has cost him, provided he is able to replace it with improved labor-saving machinery. At one time in the Carnegie works there were 800 men employed in a department which produced 1,200 tons of metal per day. Improvements were made and the result is now that 1,500 tons per day is the product of 65 men. All this has resulted in a steadily increasing production at a reduced labor cost, and this brings us to the main question: "Who is going to buy the stuff?"

Statistics of our export trade show that during the fiscal year 1900 the value of United States goods exported was $1,394,186,371. Of these our production in iron and steel alone exported during the year was valued at $121,913,548, and the total exportation of domestic manufactures amounted to $432,284,366, being an increase of $92,692,220 over the preceding year, while in no earlier year has the increase amounted to as much as $50,000,000. Domestic manufactures formed 31.54 per cent. of the total exportation in 1890, against 28.13 per cent. in 1899, 26.87 per cent. in 1897, 23.14 per cent. in 1895, and 20.25 per cent. in 1885, 15 per cent. in 1870, and 12.76 per cent. in 1860. Exports of domestic manufactures in 1860 were $40,345,892, while the total exports, including imported goods re-exported in 1860, were $333,576,057, and in 1900 $1,394,186,371. Thus while the total exports of 1900 are four times as great as in 1860, those of manufactures alone are ten times as much as in 1860. In that year manufactures formed but 12.76 per cent. of total exports, while in 1900 they were 31 per cent. Even in the decade which ends in the year 1900 the growth in exports of manufactures has been equally striking. In 1891 the total exports amounted to $884,440,810 and those of manufactures alone to $168,927,315; the total exports for 1900 being thus but 50 per cent. in excess of 1891, while the exports of manufactures are more than 150 per cent. in excess of that year. A further analysis of the official figures given by the Bureau of Statistics shows that since the year 1860 our exports of manufactures have increased ten times, while those of Great Britain have increased but one and one-half times.

But let us not be intoxicated by these signs of prosperity. We must bear in mind that during the past two years our principal competitors, England and Germany, have been passing through a boom. In the latter part of the year 1899 I visited some of the shops in Germany and found them working day and night—the principal ones being from six months to one year behind in their orders. Prices had been put up and in some cases doubled, because, as some of them said, "We believe that now is the time to make money." At that time a letting took

place of a large steam-engine plant, the award being given to an American manufacturer whose figures were a little more than one-half those of German or English builders. "You Americans need not run away with the idea that you are selling your machinery on the continent because it is so much better than ours," said a German merchant. "You are getting the business because our works cannot fill the orders; yours can, and at lower prices." Since this time things have changed. Germany and England, so far as steel and iron manufactures are concerned, are in a condition of depression. Mills are idle, or working on short time, and prices are down, so that we now have to face new conditions of competition. In addition to this, foreigners, and the Germans in particular, have caught on to our ideas, and are now in a better condition to challenge our right to foreign markets. As these lines are written reports are made showing a substantial falling off in our exports. Our exports of manufactures for January fell from $35,000,000 in 1900 to $32,000,000 in 1901. Our percentage of manufactures exported to total exports was nearly 31 per cent. in 1900, and so far this year it shows about 24.5 per cent.

During the month of February, 1901, a most unfortunate incident occurred. The Secretary of Treasury issued an order on February 14 imposing a countervailing duty of 30 to 40 per cent. upon sugar inported from Russia, and on February 16 following the Russian minister of Finance, M. de Witte, issued an order of reprisal against American imports of iron and steel products, adding thereto 30 per cent. increased duty, the order to take effect beginning March 1. The facts in the case are as follows:

A commercial treaty was entered into between the United States and Russia in 1832, by the terms of which it was intended that each party to the agreement should become the most favored nation in matters of tariff rates. Russia has three rates of tariff duties—minimum or conventional, general or normal, and maximum. The first is applied to those countries only which have commerical treaties with Russia, the second to imports of all other countries, and the third to such countries as discriminate against Russian commerce. The greatest difference between the rates of maximum and minimum tariff duties is 50 per cent. The United States, until the recent order, enjoyed the minimum rate, while now we have been placed in the category of nations which discriminate against Russian commerce, and are at the maximum rate.

In 1893 Russia negotiated a treaty with Germany and France by which special concessions were made on about 200 articles. At that

time, and in accordance with the Russian interpretation of our treaty of 1832, equal concessions were extended to the United States. The United States did not agree to this interpretation of the treaty, on the ground, as it is supposed, that this government did not interpret the most favored nation clause to imply that we were bound to concede to Russia any tariff concessions that we might make to any other nation. Through the influence, and with the support of the administration, Mr. Kasson (special reciprocity commissioner) entered into negotiations looking to a new treaty. An agreement was arrived at which was sanctioned by the Russian cabinet, the details of which have not been published, but it may be authoritatively stated that this proposed treaty was of great importance to the United States. By its terms the minimum tariff was conceded by Russia to certain products when imported over the European frontier. Among these were products of cast iron and steel and all kinds of machinery, such as locomotives, boilers, rails, etc. Agricultural machinery was admitted free. It was further offered by Russia to permit importation free of duty through Eastern Siberia of a long list of articles such as salted meat, butter, fruit, earthen-ware, chemicals, canning and dyeing materials, wrought iron, iron and steel rails, sheet iron and steel, tin plate and manufactures of tin plate, cast iron, cast-iron products and boilers, tanks, bridges, nails, carriages, bicycles, tramways, railway cars, etc.; also a reduction of duties of from 10 to 50 per cent. on hops, wine, cheese, wooden-ware, zinc and lead, telephone and telegraph wires, etc. In consideration of these valuable concessions, the United States was expected to offer a reduction in tariff of from 10 to 20 per cent. on certain articles including flax, hemp, feathers, hides, and skins, and to abolish the countervailing duty on sugar, and also to maintain the present free list.

Pending these treaty negotiations and at the request of the State Department the Secretary of Treasury issued an order dated April 20, 1900, suspending the countervailing duty on Russian sugar, it being maintained by the Russian government that no bounty of any kind was paid to sugar producers. It must be understood here that the Dingley tariff law imposes a revenue tax of from 60 to 100 per cent., according to quality, on sugar imported into the United States, and that this law requires the Secretary of the Treasury to collect in addition thereto a countervailing duty equal to the bounty which any nation may give to its sugar producers. About the beginning of the year 1901 pressure was brought to bear on the Secretary of Treasury by personal representations and through delegations of American beet

sugar producers, who are said to have acted at the instigation of the trust, to re-impose the countervailing duty on the ground that the importation of Russian sugar was a menace to the industry. The figures of importation do not appear to justify the claim made in the sugar interest. In 1900 our total imports of sugar were over $100,000,000 and of this sum Russia furnished $22,993. The Russian sugar laws were put in force in 1895. Since then our maximum importation has been $340,850 for one year, while the average for the five years since 1895 has not exceeded $75,000 per year. The United States consumes more than 2,000,000 tons of sugar per annum. The total exports of sugar from Russia since 1888 average but 90,000 tons per annum, out of her average annual production of 725,000 tons. In 1896 Russia exported 218,323 tons of sugar, in 1899 but 84,071 tons. These figures do not justify the alarm sounded in the sugar interests, and furthermore they discredit the theory that the Russian government encourages the exportation of sugar. If the Russian sugar law of 1895 may be construed as a bounty law, is it natural that the exportations should have decreased since then?

A hint was given out through the Treasury Department that the countervailing duty might be re-imposed and this drew to the subject the attention of manufacturers, who on investigation learned that the whole question was "One of facts and law." The law compelled the Secretary to impose this duty, provided the facts determined that Russia directly or indirectly gave a bounty. It was found that the Treasury Department had made no detailed investigation of the facts, that no one had gone into Russia for this purpose, and that certain statements which had been made to the department were asserted not to be the true facts by the Russian government. It was further learned that Russia had officially notified the Secretary of Treasury that any interpretation that Russian sugar receives a bounty would be considered as a discrimination against her commerce, and would make it imperative upon the Minister of Finance to impose the maximum duty on all manufactures of cast iron, iron and steel of every description, tools, and machinery of every kind. Manufacturers having interests at stake immediately proceeded to impress upon the secretary the dangers of the situation. The National Association of Manufacturers of America sent a representative to Washington, and appeals were made in personal interviews and by letters and telegrams, asking that time be given before a decision was reached, and attention was called to the following figures, showing our export trade with Russia:

Yrs.	Baltic and White Sea.	Black Sea.	Asiatic Russia.	Total.
1891	$7,260,115	$503,897	$161,580	$7,925,592
1892	5,385,627	1,313,208	120,200	6,819,035
1893	2,035,581	266,242	145,591	2,447,414
1894	6,273,623	553,852	163,855	6,991,330
1895	5,176,295	781,561	204,937	6,162,793
1896	6,298,427	1,198,223	568,002	8,064,652
1897	5,995,204	1,607,072	413,942	8,016,218
1898	6,251,202	1,084,880	618,015	7,954,097
1899	7,301,068	1,185,599	1,543,126	10,029,793
1900	6,196,892	1,241,425	3,050,102	10,488,419

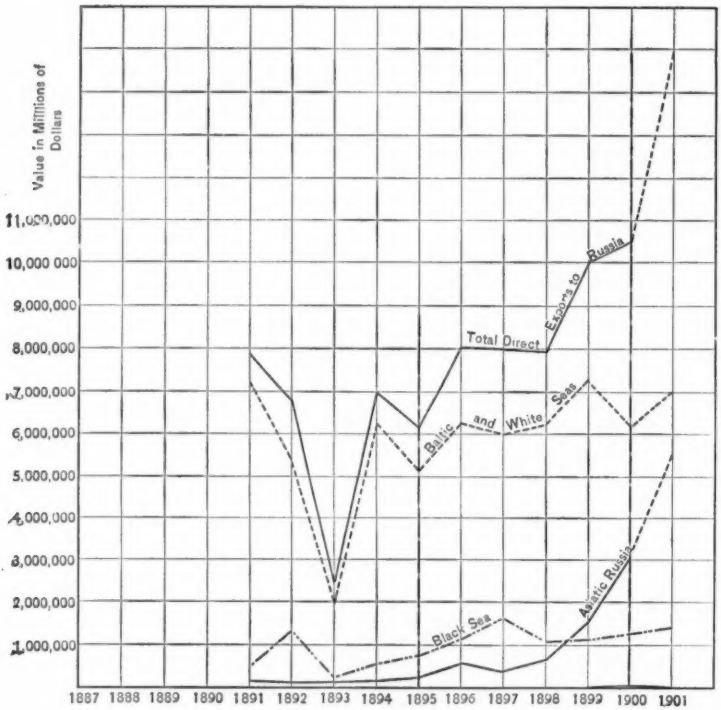
Details of the exports to Russia from the United States during the fiscal year ended June 30, 1899:

Agricultural implements	$910,947
Corn	116,039
Wheat flour	627,827
Other breadstuffs	4,285
Raw cotton	2,781,918
Iron and steel and manufactures of	3,529,052
Naval stores—rosin	294,517
Wood and manufactures of	27,876
All other articles	1,717,041
Total	$10,009,502

A letter was addressed to the Secretary of Treasury on Feb. 2 by the National Association of Manufacturers, calling attention to the difference of opinion as to the exact relations existing between the Russian government and the sugar interests, and the burden of responsibility thereby placed on the secretary in making a decision, and asking that a representative of the Government be appointed to visit Russia and to investigate all the facts, and that the sugar interest of the United States and the National Association of Manufacturers be each allowed to send a representative at their own expense to accompany the Government official to the end that these three investigators might mutually aid one another and agree upon a final and thoroughly informed report. On Feb. 14, however, the Secretary of the Treasury issued an order to all officers of customs directing assessment of additional duties of .50 rouble per pood on sugar testing not less than 99 per cent., .44 rouble per pood on sugar testing not less than 88 per cent., and .38 rouble per pood on sugar testing less than 88 per cent., as the "net amount of bounties paid or bestowed by Russia on the export of sugar."

Two days thereafter a cable from the United States Ambassador at St. Petersburg announced that Russia had retaliated as follows:

"An order of Russian Finance Minister directs additional tariff



AMERICAN TRADE WITH RUSSIA: EXPORTS OF ALL SORTS TO RUSSIA.

of 30 per cent., net, imposed upon articles included in paragraphs numbered 150, 151, 152, 153, 161 and section 2, and discriminating tariff upon American hardware, iron and steel boilers, pipes, forgings, castings, tools, gas and water meters, dynamos and sewing machines, of paragraph 167 of the Russian tariff laws, when such articles are of American manufacture. This includes motors and machinery of all kinds, to take effect March 1."

As the mischief has been done it is useless, perhaps, to dwell upon the reasons which induced Secretary Gage to act. His own words in explanation contain the following clause: *"In the present case the facts are involved and the conclusions to be drawn from them are correspondingly difficult."* The Secretary conferred with the Attorney General on the subject and the following statement has been made by a

gentleman of high standing in Washington, who saw the Attorney General a few days before the Secretary's order was issued: "He (the Attorney General) stated to me as a lawyer that, in his opinion, a preponderance of evidence must be adduced showing that a bounty was paid or a grant made by Russia within the meaning of the Dingley tariff act before the Secretary was authorized to impose a countervailing duty; that the authority to enforce this provision of the act *must not rest on any doubtful facts, but that the evidence must be clear and convincing.*"

Briefly stated the facts are as follows: The Russian government, being paternal in its character, has absolute charge of all manufactures. Among these is sugar. It levies an internal revenue tax on all sugar ground for consumption in Russia. The government fixes a certain limit above which no sugar shall be ground for home con-

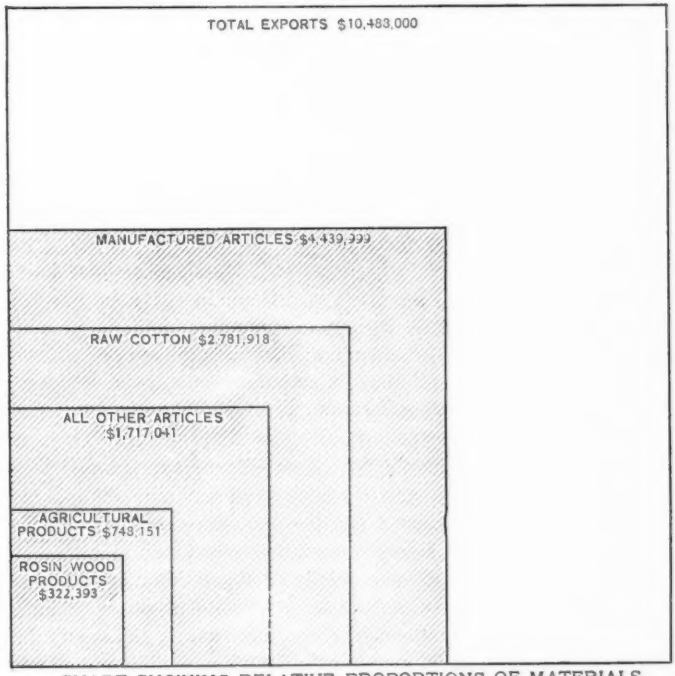


CHART SHOWING RELATIVE PROPORTIONS OF MATERIALS EXPORTED FROM THE U. S. TO RUSSIA
Year ending June 30, 1899

sumption. Each factory is assigned its individual allotment of the whole amount which it may grind for government use to be consumed in Russia. Beyond this allotment the factory may grind all the sugar it pleases, but it cannot sell the product in Russia. The government keeps about 10,000 tons on hand as a surplus, so that in the event that sugar grinders combine to force up the price of sugar the Russian government can dump its surplus stock on the market and force the price down. Such being the fact in Russia, the only possible outlet for a surplus production of sugar is export.

Sugar which is exported pays no excise tax, or if an excise tax has been paid it is refunded on exportation. This brings us to the first question.

1. Does the absence of an excise tax constitute a bounty?

If we define a bounty as a premium or reward, something which enables the producer to lower the cost of the article, then the absence of a tax is not a bounty. Should the government refund on exportation a *larger amount* than the actual internal tax this would be a bounty; but the government refunds exactly the tax paid, and this can no more be construed a bounty than the act of the United States government in refunding, on exportation, duties which were collected on importation.

2. Do not the Russian laws, which have been established for the purpose of limiting the production of sugar, encourage exportation and thus create an indirect bounty?

Let us first consider the purpose which Russia may have had in mind in establishing such laws. It is difficult in any country to determine accurately what the beet-sugar crop from year to year will amount to. It is especially difficult in Russia because the climate of Russia is so uncertain and variable and the crops are so dependent upon the climate that planters cannot foresee results. The population of Russia is in the main moujiks or poor people. There are 100,000,000 moujiks and 30,000,000 educated people in Russia. Now, if times are good, the poor people consume a great deal of sugar, and the reverse is true during hard times. Statistics show that the consumption of sugar falls off very materially during famine years.

In order to insure a sufficient supply of sugar in advance the government makes an estimate and allots a definite production; but to insure against overproduction and demoralization of prices this production is limited. Now we see that the Russian government protects both the sugar grower and manufacturer and through this protection the manufacturer is insured a good price for his home product. If he

attempts to impose upon the consumer by running up the price too far, the hand of the government is shown in dumping the surplus stock upon the market and thus bringing prices down. As a matter of fact, the Russian consumer pays nearly seven cents per pound for sugar which is sold at the same time in the English markets for four cents.

London is an important market for Russian sugar and in 1896 the figures show that the price in Russia was £30.30 per ton, while in London this sugar was sold at £11 per ton. After making allowances for the excise duty on the home product, there still remains an apparent loss of £8.6 per ton exported. This does not appear to be an encouragement for exportation, and were it not for the very profitable business done at home Russian manufacturers would be ruined by a large export business.

In Russia the government fixes the maximum price by law, while in the United States precisely similar results are obtained by the operation of our tariff laws. Should our sugar trust attempt to put up prices of sugar beyond a certain point, foreign sugar would come in and operate precisely as the Russian reserve does—to bring prices down. The Russian sugar merchant makes so much money at home that he can afford to sell even at a loss for exportation, and this is exactly what takes place in the United States. If this is a bounty, then the products of the United States are in danger of being subjected to countervailing duties from foreign governments. But there is a difference between the Russian laws and ours in that in Russia the operation of the law has shown that the maximum price is gradually reduced, and thus an advantage is given to consumers. The following are the figures which show this:

MAXIMUM PRICES OF SUGAR IN RUSSIA. (Rubles per Pood.)

For 1895-6.....4.75 (before 1 Jan.), 5.00 (after 1 Jan.)
For 1896-7.....4.65 (before 1 Jan.), 4.90 (after 1 Jan.)
For 1897-8.....4.60 (before 1 Jan.), 4.60 (after 1 Jan.)
For 1898-9.....4.50 (before 1 Jan.), 4.50 (after 1 Jan.)

It is therefore seen from the above that the main object of the Russian law is to regulate the production of the sugar in such a way as not to encourage an oversupply in excess of the yearly increase of consumption in the home market, and at the same time to secure for the consumer a reasonable and constantly decreasing price, made possible by improvements made from year to year in the industry.

Prior to 1887 Russia paid a bounty of about one cent per pound on sugar exported; but in that year further payment of bounty was stopped on the ground that the government "did not desire to supply

foreign markets with a cheap sugar at the expense of the imperial treasury, it being determined that bounties could be omitted without bringing the sugar industry to a critical situation."

Russian refineries have certain arrangements among themselves by which one refiner sells to another his right to supply a certain quota of sugar to the home market. A refiner near a seaport sells his home right to one in the interior and exports his stock, the difference being made up by exchange among themselves of government certificates of exportation, which are said to be subject to barter and sale in Russia. This is an internal private business arrangement among the merchants. The government has no more to do with it than has the United States government with a combination among steel merchants to put up the price of steel rails, and doing this to buy out some small producer who agrees not to sell in the home market but to ship his product abroad. The bills of lading or export certificates which are sold in Russia are of no more consequence than our using bills of exchange instead of shipments of merchandise in business transactions.*

The facts do not appear to sustain the contention that a bounty is paid. The Russian system is certainly different from that in all other countries where bounties are known to exist. The government does not give directly or indirectly anything to the producer which enables him to reduce the cost of the product. The quantity sold at the home market is fixed and the price is profitable; hence every pound exported reduces the profit by the loss in its sale. Were it physically possible, Russia would produce only enough for the home market and no more. What definition of bounty can be applied to this case? It is on the contrary really the American system improved. Suppose all countries should agree to abolish bounties; what would Russia be expected to do and what would we do in the United States.

It is interesting to note here that in the year 1898-99 the Russian government purchased from the Maryland Steel Co. 120,000 tons of steel rails for use on the Trans-Siberian Railway, the price being $17.75 per ton, at this time ruling prices at home were from $33 to $35 per ton. The iron from which this steel was made was produced

* A consular report made at the request of the Treasury Department and published in the Congressional Record states:

"The manufacturer who ceded his right receives from the manufacturer who acquired the right the price per pood agreed upon between them, which is usually determined by the difference existing at the moment between the price obtainable for sugar on the home market and the price obtainable by sale abroad. This is what is termed a transfer. Dependent on the fluctuations in price of sand sugar in Russia, and abroad, the price of these transfers also varies; therefore the person who sells the transfer (the right of issue into the home market) charges several kopecks more than the difference mentioned above. This is done on account of the risk that is taken that sugar prices abroad may fall and also for the trouble involved in exporting, etc."

from ore imported from Cuba, and it is a matter of record that the steel company at Sparrows Point recovered on the exportation of these rails 99 per cent. of the duty which had been paid on the ore.

Efforts have been made to belittle our trade with Russia. It is doubtful that any of the figures published represent the true value of Russian business. The long time credits there and the lack of knowledge which American exporters have of business conditions have developed an indirect business with Russia, principally through Germany. German merchants buy American goods and re-ship into Russia. They are closer at hand and have a better knowledge of the country; besides, many of them have direct representatives in Russia, or at least are represented through the banks. One exporter in New York, Markt & Co., do a business of about $750,000 per annum there, a large proportion of it going through German merchants. Markt & Co. say that since the Secretary's order was issued they have received cancellations of orders in amount greater than the total annual imports of Russian sugar. Even in Savannah, Ga., an order for 40,000 barrels of resin (not affected by M. De Witte's reprisals) has been countermanded because of this trouble. These are specific cases which indicate a far-reaching effect in this unfortunate affair. Coming just at this time, when a billion-dollar steel trust has been organized, it excites thoughts of reprisal among other nations and unless the United States Senate gives speedy relief by passing some of the reciprocity treaties, our exports will be seriously affected, if not ruined. Germany, close at hand and jealous of the inroads made by American exporters, is now on a more favorable tariff basis with Russia on a very large number of articles for which American manufacturers have at great expense built up a market. German exports to Russia are now over $100,000,000 in manufactured goods alone. Even if it be true, as claimed by our Treasury Department, that but a few million dollars worth of export business has been affected by M. De Witte's order, see what possibilities were before us.

In a remarkable book on trade treaties by Dr. Vosperg-Rekow Russia is referred to as the promised land for Germany's manufacturers and exporters. He goes on to say: "Our commercial relations with the empire are already very intimate; 12 per cent. of our imports come from Russia, while she takes one-tenth of all of our exports. The business transactions with Russia are among our most profitable; we sell her goods at high price and take hardly anything but cereals and raw materials in return. Therefore we must be extremely careful to retain this good customer. America is not nearly

as profitable a customer to us as Russia is, and should we adopt measures to shut out foreign grain we must spare Russia, even though we differentiate against America and other countries."

We cannot always sell unless we also buy. The commercial position of the United States would be weakened, not strengthened, by a policy which looks to receive money alone in payment for its products. Unless the purchaser in a foreign country is given a chance to sell us something in return, the time will come when he will not be able to purchase anything. All trade to be permanent must be reciprocative. One of the drawbacks at present in shipping American products abroad is that there is no opportunity to get a return cargo. Hence, in order to maintain the permanence of our present position as a great exporter, we must labor to be a great importer as well; and it would seem to be clear that the first step in this direction is to lower the tariff on raw materials.

M. de Witte, who is perhaps the ablest statesman in Europe today, is a protectionist of no uncertain type. At the age of forty-four he fought a tariff war with Germany to a successful issue, and Mr. Henry Norman, in the March number of *Scribner's Magazine*, says: "Since that time his high-tariff neighbors have taken good care to give him no grounds for reprisals." "History shows," said M. de Witte, "that exclusively agricultural countries, even when they are politically independent and internationally powerful, are economically restricted to the *rôle* of tributary colonists. . . . . Like all other methods of action, protection should only be regarded as a temporary measure, in force until the time comes when its object is reached." "I believe," said President Garfield, "in that protection which leads to free trade."

If the bars of protection serve as they do now in the case of this Russian business, as dams to obstruct the flow of our products into foreign fields, then let us take them down. Mr. Blaine, a disciple of protection, evidently saw clearly that reciprocity was essential to the maintenance and integrity of protection; hence he coupled it with his protection idea. If protection has built up the United States to its present position, and if to be a great manufacturing country is desirable in the interests of the whole people, then it is as important now to protect the manufacturers by open doors as it was to build them up by a tariff which has now become useless and which has begun to be hurtful.

Oil Wells at Bibi Eibat. Photo by Dr. E. O. Hovey.

ENGINEERING OPPORTUNITIES IN THE RUSSIAN EMPIRE.

By Alexander Hume Ford.

Mr. Ford's series of articles on Russia's marvellous industrial expansion and mechanical needs began in the February issue of THE ENGINEERING MAGAZINE. They were, of course, prepared before M. de Witte's tariff measures, directed against the United States and Germany, had attracted all eyes to the huge prize which Russia offered to those manufacturers whose home tariff policy does not debar them from the competition. This impartial measure of the value of the opportunity, obtained by the personal observation of a competent authority, gains yet greater value from the recent course of events. Mr. Ford, as an unbiassed American engineering traveller, writing before there was any menace of the closure of Russian markets to protectionist countries, irresistibly reinforces Mr. Saunders' paper preceding. He confirms from within what Mr. Saunders discerns from without—the almost boundless opening which Russia affords for an unfettered commerce.—THE EDITORS.

THE men in America to-day who best understand the mechanical needs of Russia, and control the export of manufactured articles and machinery, are mostly Russian or ex-Russian subjects, many of them graduates of the leading Slavonic universities, who have emigrated to the United States on account of the severe persecutions of the all powerful Orthodox Greek Church. For centuries the traders and merchants of Russia have been either foreigners or native born Jews; the latter, accustomed for generations to guard the secrets of their trade, are not now disposed to kill the goose of the golden egg by laying bare to every American the knowledge which is theirs by right of inheritance.

With friends and relatives in every center of business activity in Russia as agents, and co-religionists in the cabinet of the Tzar; with the Trans-Siberian and other railways largely under the direction of Hebrew architects and constructors; with the government looking to

OIL REFINERY OF NOBEL BROS. SYNDICATE AT PETROLIA, NEAR BAKU. PETROLEUM IS RUSSIA'S MOST IMPORTANT FUEL.
Photo by Dr. E. O. Hovey.

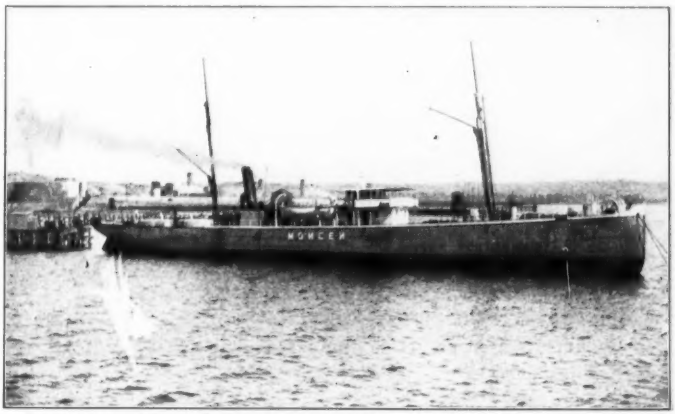
the same race to supply its financial advisors, even turning over to them the Russo-Chinese Bank, now all powerful from St. Petersburg to the Pacific—those of this tirelessly energetic people whom Russia seeks to exile from her domains flock to Anglo-Saxon shores, where, no longer poor and despised, they have formed a great clearing house, through which America transacts the enormous business being built up between the two nations. In England, with the great Rothschild as patron, the services of this people have proved valuable to every worker in the machine shops of Great Britain, so that owing to the irrepressibility of his nature, it has been possible for the Russian Jew in exile not only to better his own condition and uplift himself to heights he little dreamed of a few years ago, but to bring the great Anglo-Saxon and Slavonic nations into closer bonds, much to the lasting advantage of both, and of himself.

In fact, until quite recently the foreign commerce of Russia was entirely controlled by comparatively few foreigners who spoke her language and held special privileges from the Tzar's government. But now the work accomplished by these foreign merchants, including generations of Englishmen who have represented British commercial houses in Russia, the business results of which are naturally guarded as secrets of the trade—threatens to become the property of all; for after half a century of antipathy toward the Briton, the jealous Slav has sent forth hordes of lowly exiles, who have found it to their commercial interest to act as peacemakers, so that once

more, as before the Crimean war, the Anglo-Saxon is pouring into Russia on business bent, and Russia is eagerly reaching hands across the sea to both America and Great Britain.

The Imperial Government, to encourage mutual commerce, is about to remove all tariffs from iron, machinery, and other material necessary for building steamships, so that Russians can construct the boats necessary for the desired direct lines from Odessa and St. Petersburg to New York, favored by the Tzar, but which the Americans have been slow in materialising; so that, after all, the Russo-American Steamship Company promises to be a Russian-owned and subsidised affair, while the steamers which are to carry Siberian chilled beef and dairy products to London will be Russian, and are already promised a liberal subsidy as soon as they are placed in commission. The dairy exports of Russia have risen in a few years from less than $100,000 in value to over $20,000,000, so that they now need larger markets than little Denmark, while from England and America return cargoes of dairy and farm machinery will be encouraged. But it is not necessary to go inland to begin observations as to what Russia needs from without. Almost my first landing in the Russian Empire was upon a two-million-dollar pier, constructed in part with and of material from both America and England.

Piled up in great mountains of packing cases, or lying loosely about on the vast pier, were pieces of machinery, locomotives, rails, hand cars, boilers, steam rollers, all bearing the stamp of some well

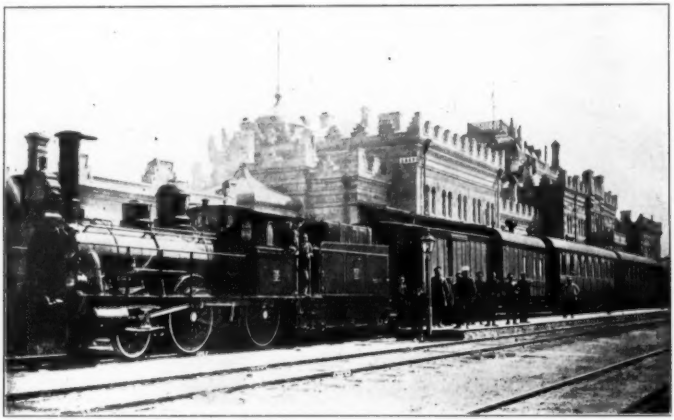


OIL TANK STEAMER MOÏSEÏ, ON THE CASPIAN AT CHORNY GOROD, THE "BLACK CITY," NEAR BAKU.
Photo by Dr. E. O. Hovey

known American house, while on the same pier were great sections of steel barges made in Scotland, for use on Russian waterways.

After visiting other Russian ports, I lost entirely my surprise at invariably witnessing the predominance of Anglo-Saxon enterprise in the Tzar's domains. Each part of the Empire seems to require different kinds of machinery and supplies. At Odessa and Azof seaports, it is a common sight to observe miles of Chicago-made reapers and other agricultural implements awaiting shipment inland, while at Batum is unloaded machinery for the oil wells, the tubing for the pipe lines being constructed by a Russo-American factory in Russia.

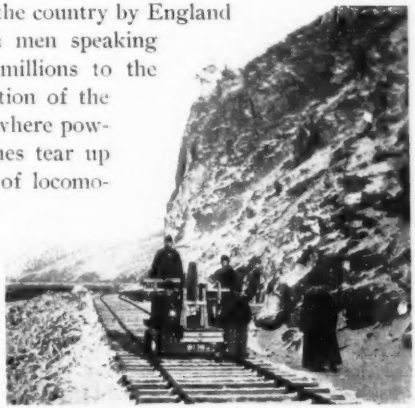
In the west, machinery for electrical plants, railway material, and mill machinery find their way to Riga and St. Petersburg, while in



AN EXPRESS TRAIN AT BAKU STATION.
By courtesy of Dr. E. O. Hovey.

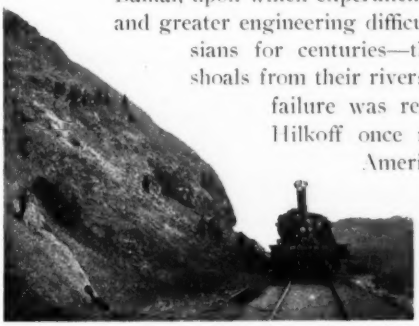
the east the result of the Tzar's ukase abolishing all tariffs on materials entering Pacific ports of Russia has had the desired effect of vastly increasing Siberia's commerce with America. Through these Siberian ports passed the rails, ties, locomotives, and equipment of the Manchurian and Eastern section of the Trans-Siberian Railway, to say nothing of the iron work for bridges and material for constructing and supplying new cities and workshops—all of which must be done over again at a cost of many millions; for the railroad where completed has been torn up by the Manchus, equipment destroyed, and workshops burned. In fact, from one end of Russia to the other, a great field is opening up for the engineer who can explain to his Russian confrères and others the best methods of utilizing the com-

plicated machinery sent into the country by England and America. A few such men speaking Russian could have saved millions to the Government in the construction of the Manchurian Railway alone, where powerful American mogul engines tear up the light rails, while scores of locomotives, built with fireboxes for burning wood, lie idle by the roadside in a country where even crossties must be imported from across the Pacific. Prince Hilkoff, the head of all railways and means of water communication in Russia, best understands the remarkable faculty possessed by the American engineer for designing and the English for carrying out those designs; for the prince spent several years in America as an employee of the Pennsylvania Railroad, studying Yankee engineering methods.



A RUSSIAN-MADE HANDCAR.

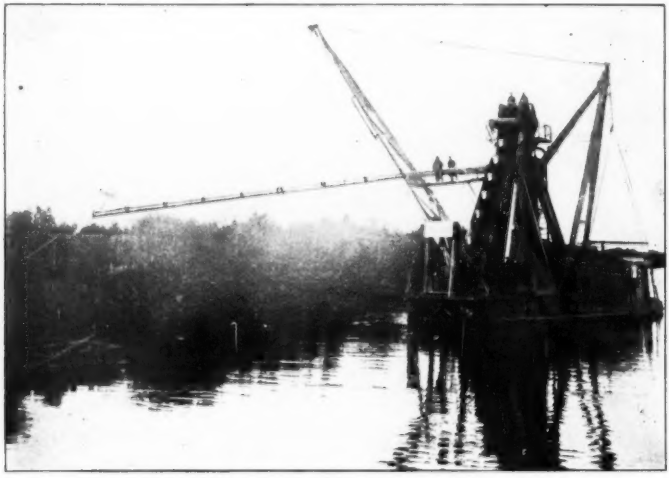
After the Russian and other European engineers had failed in their efforts to supply any effectual means of keeping open in winter the ice-clad ports of Russia, a commission was sent to America to look into the system in use on the Great Lakes, with the result that within a year or two after the report of the commission, duplicates of the Great Lake ice-breakers were ordered from English ship-builders, and now keep ice-free the year round the Baltic and Pacific ports of Russia, to say nothing of the Arctic harbors and the waters of Lake Baikal, upon which experiments are being made. Another and greater engineering difficulty has confronted the Russians for centuries—the removal of the shifting shoals from their rivers and harbors. Failure after failure was reported, until at last Prince Hilkoff once more bethought himself of American methods, and Lindon W. Bates, of Chicago, was induced to visit the chief rivers and harbors of Russia, for the purpose of making a private report to the government



ENGINE BUILT AT SIBERIAN WORKS

as to what he considers the best method of accomplishing the desired results.

Mr. Bates made his report, returned to Chicago, and drew the plans for the largest dredger ever constructed. It was to excavate a channel 14 feet deep and 80 feet wide at one cutting, and to burn naphtha at the rate of 1,200 gallons an hour. The plans were given to an Anglo-Belgian firm, which proved so successful in carrying them out, that the "American dredge" became famous all over Europe almost upon its completion. Representatives from nearly every government came to see this wonderful boat, propelled by electricity, tear its way along the bed of the river, digging a channel as it passed. From Australia, India, and other countries came orders for duplicates, and Russia, having already spent over $30,000,000 on her waterways in the last few years, has recently given an American a $7,000,000 contract to deepen her Pacific Ocean harbors, and is ready to order a still larger "American dredge" and many smaller ones. If these craft are hereafter built in Russia, the material will doubtless be



A LARGE BUCKET DREDGE WITH SPOUT DISCHARGE AT WORK ON THE ALEXANDER III. CANAL.

allowed to enter duty-free, and no doubt many Americans and English engineers and electricians will be needed to guide those who build and operate the dredgers; for in spite of the fact that the government has established technical schools and engineering colleges in every part of the Empire, the graduates of which hold military rank and must be

employed before any outsiders are called in, there are certain positions open only to those who have studied in that particular branch.

To secure a great factory and mechanical plant in Russia, the government gave the Westinghouse Company an enormous order to supply passenger and freight trains in the Empire with their air

CITY OF ZLATOOUST. THE OFFICIAL BEGINNING POINT OF THE SIBERIAN RAILWAY. CENTER OF THE SOUTHERN URAL MINING REGION, AND SEAT OF A LARGE IRON FOUNDRY

By courtesy of Dr. E. O. Hovey.

brakes, upon condition that they would manufacture them in Russia. It was, of course, necessary to put only experienced men at the heads of all departments, and so it was that over a hundred expert English and American engineers and workers find lucrative employment in St. Petersburg, where the Westinghouse works are located. At first it was necessary to import the rough castings, and, of course, all of the machinery for equipping the plant. Now, however, everything is made in Russia.

It is in this way that the Tzar is seeking to make Russia industrially independent of other nations. Another American company has been induced, by a promise of paying orders, to erect locomotive workshops in Russia. The equipment, of course, will be imported, and American mechanics will be in charge of the shops. By degrees, Russia will become a manufacturing country, but it will be many years

before she will be able to compete with the older manufacturing nations, which, in the meantime, should reap a golden harvest fitting her for the position she desires to hold as their competitor.

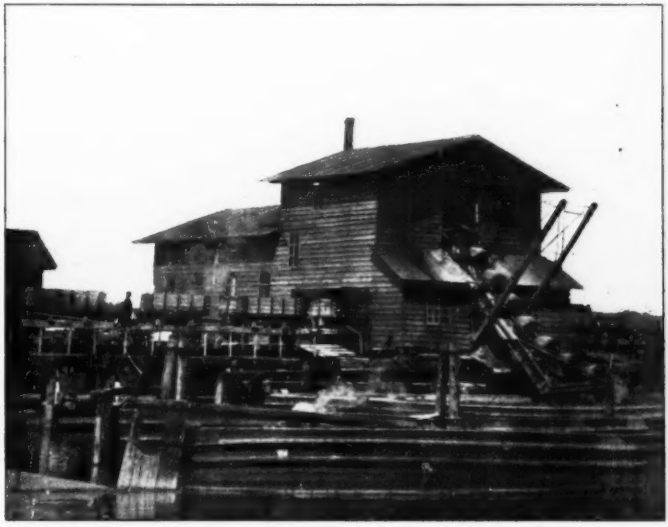
It should not be forgotten that while America and Russia are the only two great nations exporting more than they import, and America is seemingly the most prosperous, she has not the wonderful undeveloped resources possessed by Russia, the stupendous natural system of inland waterways, nor the vast extent of territory. It will doubtless surprise many to learn that Russia is a greater cattle and sheep-raising country than the United States, and needs machinery for her tanneries and leather-working factories, which are constantly being

THE DEMIDOFF IRON MINES AT NIJNI TAGHILSK, SHOWING GENERAL CHARACTER AND EXTENT OF WORKINGS.
By courtesy of Dr. E. O. Hovey.

erected. Soon there must begin to grow a demand in Russia for all the mechanical appliances necessary to well-equipped modern stock yards and packing establishments. Someone must teach the Russians how to conduct this great plant. Some years ago, an Englishman built and equipped for the Tzar a sugar refinery. It is now, although one of the many sugar refineries, but one of the few in all Russia perfectly equipped with modern machinery, including electric motors and turbines for making use of water power, but it is a sign of the times.

Sugar making has become in Russia a protected monopoly, paying enormous profits and utilizing the product of over one million acres

of beets. Many of these plantations are irrigated, and the various makes of pumping windmills are coming into use. Russia is also fast becoming a great manufacturer of cotton goods; but it should not be forgotten by engineering enthusiasts that, owing to the fact that there is a plentiful supply of labor, wages are absurdly low, while a high tariff so protects the manufacturer that he can afford to buy discarded, antiquated machinery from mills and factories of other nations, and even then compete with them in the Russian market. With the inpouring of foreign capital, however, which seems to have begun, many new industries are being started, and to remain in the field the



A RUSSIAN GRAIN ELEVATOR. MECHANICAL CONVEYOR TAKING GRAIN FROM CANAL BARGES.

old companies will have to purchase up-to-date equipment and employ experts to install and superintend the working of the new plants.

But it is not the industrial enterprises which mostly interest the Anglo-Saxon engineer and mechanical genius. Russia is awakening to the uses of electricity; various cities, from Odessa on the Black Sea to Vladivostok on the Pacific, are inviting estimates on trolley systems and electric lighting. I have stopped at Russian hotels which have ordered out the flimsy French incandescent plant, to be replaced by the more reliable up-to-date American system. Even the Franco Alliance does not guarantee favoritism. Only recently, the city of

Odessa gave an American firm an order for the piping for the construction of her sewerage system. The French Ambassador at St. Petersburg protested and insisted that the contract should be annulled and then awarded to French firms; but in spite of the request of the Russian Minister, this Odessa refused to do. On another occasion, the American consul held up bids for rail until he could cable American firms, one of which secured the order.

There is no prejudice against the American drummer in Russia, although he is taxed fully as much as others. Every foreign firm doing business in Russia must pay an annual tax of $750, unless it establishes a branch factory on Russian soil, when the tax is reduced two-thirds. In fact, in every way are foreigners induced to aid in the development of the great Russian empire. Last summer, in Siberia. I met young American drummers (who had learned Russian) enthusiastic over the possibilities of invading that part of Russia. This year the Siberian merchants would exclude all competing American products and manufactures did not the strong hand of the government prevent. While at the other end of the line, in Europe, quite recently I heard it stated by more than one Russian official that the American colony in St. Petersburg had grown within a few years from a handful to more than a thousand in number, and the cry is "Still they come."

The English, following the example of the Germans, have gone about the work of securing Russian orders in a businesslike manner. They publish a Russian business paper at Moscow, and give purchasers six months or a year in which to settle their bills. American business men seem content to rely on the exertions of the various consular agents, for it is only through the influence of their Minister at St. Petersburg that any progress has been made towards holding the proposed machinery exhibit in St. Petersburg next summer, and now that the likelihood of an International Exposition at St. Petersburg in 1904 grows, the two may be merged. With the exception of France, other foreign nations seem to have overlooked the importance of Russian fairs, especially that of Nijni Novgorod, as means of introducing what they have to sell. At Nijni Novgorod more than $40,000,000 worth of material still change hands annually: here the starosta, or chief of the village artel, comes to buy the supply of raw material on which the moujiks will work during the long winter days. Tons of iron, boilers, and various kinds of machinery are sold here; turning lathes, and such machinery as the peasants can use in common, are in demand; machinery for cutting shingles, axe handles, and wood-turning tools

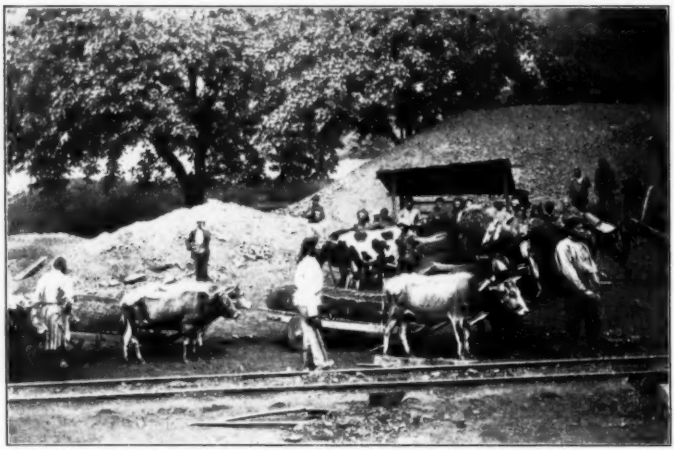
would find a ready sale; but the Russian insists upon seeing a piece of machinery work before he will purchase, which is one reason that over one hundred and fifty American firms have combined in southern Russia to aid each other in introducing the mechanical devices of their country.

German manufacturers have long since seen the wisdom of such co-operative methods, and further, they educate their young men to go forth and represent certain lines of goods. In a similar manner, American and English manufacturers of machinery would find it to their interest to send out engineers capable not only of explaining the

THE CITY OF NIJNI NOVGOROD, A CENTER OF RUSSIAN COMMERCIAL ACTIVITY.
By courtesy of Dr. E. O. Hovey.

working of various kinds of machinery, but able also to prepare plans for the construction of bridges, factories, electric plants, trolleys, water works, drainage, sewers, gas pipe, or other systems or improvement which may be desired by individuals or civic bodies; for it must not be lost sight of for a moment that Russia is spending every cent she can possibly borrow in developing her magnificent resources. New and mighty canals are to be cut, rivers and harbors deepened, arid lands irrigated, forests cleared and waste lands reclaimed; cities, villages and workshops are being built, colonies are planted in new localities, where modern systems of drainage and agriculture are being introduced.

Not only is all Russia alive to the stupendous evolution taking place, but France, Germany, and Belgium are investing all the money they can spare in Russian factories and other enterprises. Even in St. Petersburg many millions are raised yearly for the exploitation of coal, iron, gold, and copper mines in the Urals and beyond. For these,



MANGANESE MINING BY PRIMITIVE METHODS, STILL IN USE IN PARTS OF RUSSIA.

new and efficient machinery is needed. Many Americans are interested with these Russian investors, and both English and American engineers are even now prospecting almost everywhere in the Empire, where it is probable any mineral is to be found.

Additional chance of employment is opening up to the Anglo-

WASHING PLANT OF THE MIASK GOLD PLACERS.

Photo by Dr. E. O. Hovey.

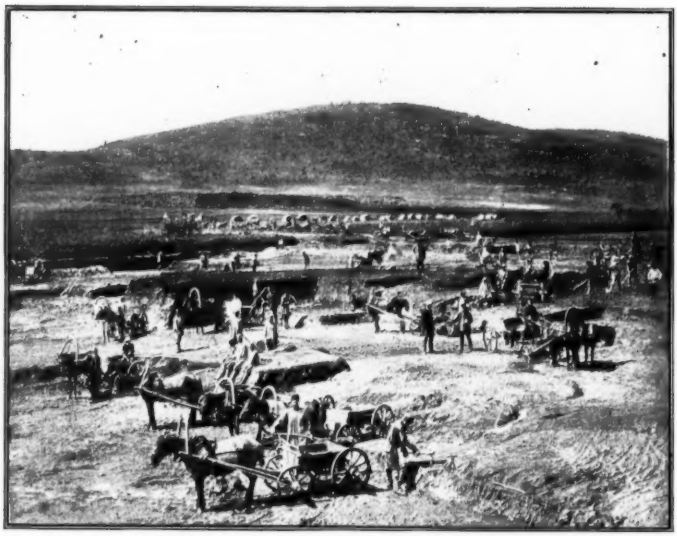
RIFFLES OF THE MIASK GOLD-WASHING PLANT.
Photo by Charles Palache, Esq.

Saxon engineer, who is willing to superintend the erection and fitting of the flour mills, whiskey stills, canning machinery, saw mills, mining machinery, electric plants, and steel frame buildings, which America is sending over in ever increasing quantities.

I have seen simple machinery for mills and mines lie idle for months in Asiatic Russia, because no one could be found who knew how to superintend its erection. In fact, Russia seems to stand to-day where America stood half a century ago, on the threshold of an industrial prosperity and development which must soon awe the world by its rapid and stupendous growth. It is here that the Goulds, Rockefellers, Huntingtons, Carnegies, and Flaglers of the future will spring up and become all powerful.

The government is setting an example in erecting the most modern and perfectly equipped machine shops the world has yet known. This example she induces private individuals to follow by assisting with vast loans of money those who embark in new enterprises; and one by one as they are started, the bars are put up against foreign competition. Already the almost prohibitive tariff of $3 a ton on iron has

GOLD QUARTZ MILL OF WONLIARLIARSKY CO., ARCHANGEL MICHAEL MINE, NEAR TSCHELIABINSK, EASTERN URALS.
Photo by Charles Palache, Esq.



GENERAL VIEW OF DIGGINGS, ILMENSKI GOLD PLACER NEAR MIASK, EASTERN URALS.
By courtesy of Dr. E. O. Hovey.

caused many foreign workshops to seek sites in Russia where 90,000,000 peasants, idle for six months of the year, gladly work for a pittance, while the government guarantees that they shall not strike. In districts where coal is scarce, if it is necessary for the welfare of the fondled industries, the tariff is remitted, so that at present both American and English coal finds its way into the Tzar's domain.

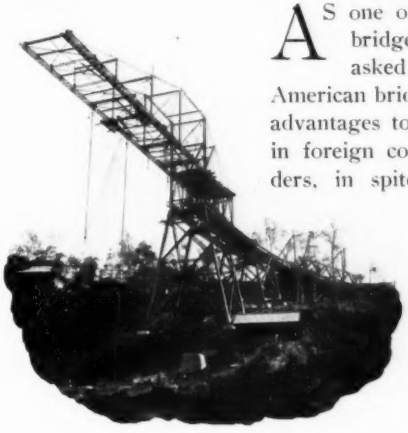
Russia will make many sacrifices to avoid war, which would interfere with, if not put a complete stop to, her internal development. Least of all does she desire the ill will of America. She much prefers Anglo-Saxon yellow gold to its cold lead. Her masterful diplomats may be trusted to make any concession likely to stimulate Anglo-Saxon activity in the way of investing in Russian industrial enterprises, so that her two greatest rivals, England and America, may become so deeply interested financially in the welfare of the Russian Empire that they will be compelled to force her development as a means of protecting their pockets.

This seems to be the game Russia is forcing us to play with her, and as it is seemingly the only one at which all can win, it is not likely that she will find her associates backward in playing their hands.

EUROPEAN AND AMERICAN BRIDGE-BUILDING PRACTICE.

By Thomas Curtis Clarke.

Exactly ten years ago, under the title "The Greatest Bridge in the World," Mr. Clarke contributed to the initial number of THE ENGINEERING MAGAZINE a study of Sir John Fowler and Sir Benjamin Baker's great Forth Bridge. That remains to-day unrivalled in majesty and boldness of conception. Neither Europe nor America has been called upon to carry out a work of similar size. But in the demands which have been made, for thorough work under difficult conditions and with the maximum economy of time and money, America has passed her older teachers and rivals and challenged the attention of the world. Mr. Clarke's present review is concerned with the perfection of mechanical methods by which this has been accomplished.—THE EDITORS

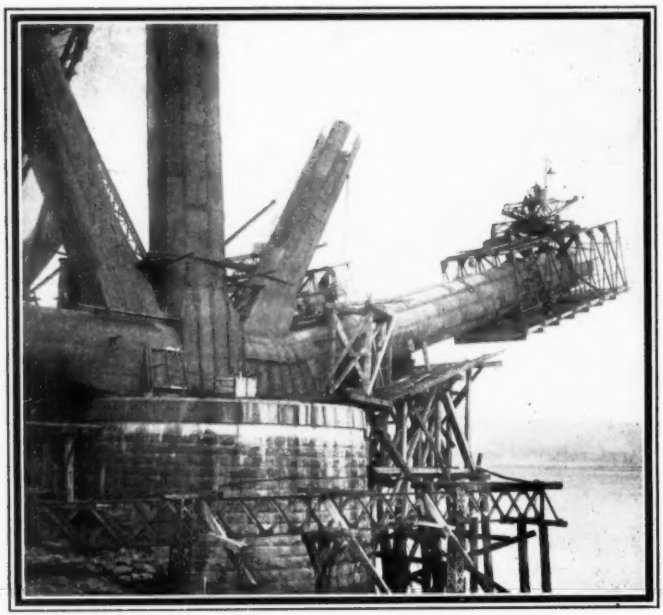


AS one of the pioneers of American bridge construction, I have been asked to give the reasons why American bridge companies can offer such advantages to purchasers of steel bridges in foreign countries that they obtain orders, in spite of that prejudice which naturally favors one's own countrymen. The brief answer is that Americans are twenty years in advance of other nations (except Canada) in the art of bridge design and construction, as a short explanation will serve to show.

The steel of which a bridge is made represents about half of its cost. Steel is now made in the United States at much less cost than in any other country. In Britain, labor is so much hampered by trades-unionism that it is admitted by one of their leaders that the cost of labor in making steel in the United States is not one-half of what it is in Britain. This can be said also of the labor employed in manufacturing. Maxim tells us that after he had perfected a machine tool for making a certain part of his gun, a union leader fixed the output at one and one-half pieces daily. The mechanic did not dare to make any more. Maxim imported a machinist from Germany who turned out from six to eight pieces daily.

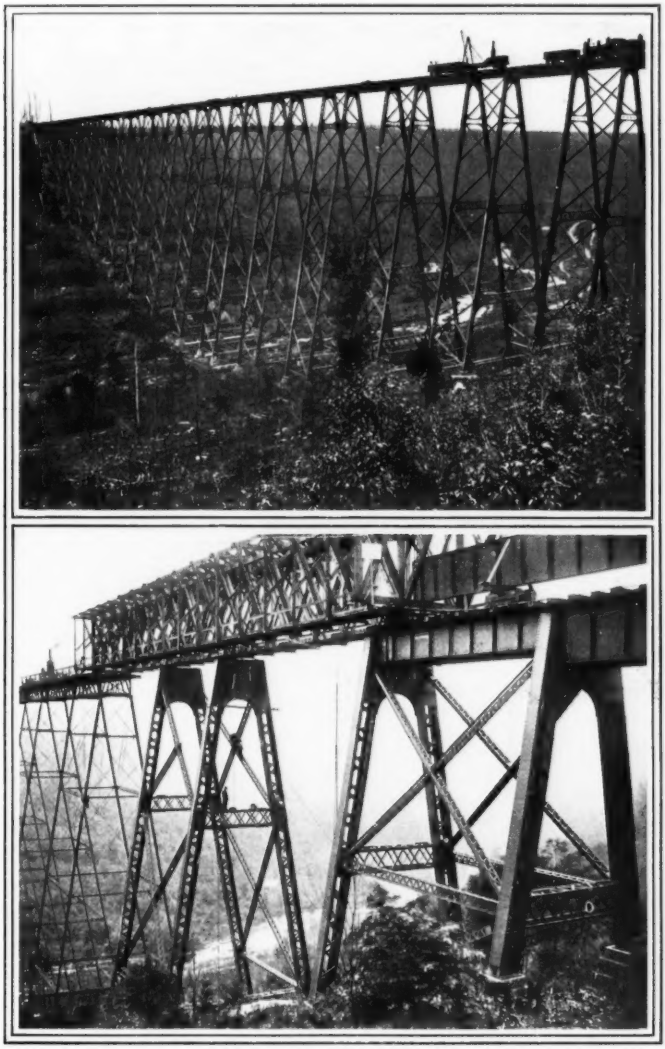
The market for bridges is far greater in the United States than

elsewhere. The States have now 190,000 miles of railways, and it has been estimated that there is an average of one span of metallic bridge for every three miles of railway. This gives 63,000 bridges on existing lines, without including those required for new lines. The increase in the United States of the weight of cars and engines has resulted in wonderful economic changes. The average rate of freights on American railways was in 1867 a little over five dollars per ton. Now it averages ninety-five cents. Any one can figure the



THE BEGINNING OF ONE OF THE GREAT CANTILEVER SPANS ON THE FORTH BRIDGE—THE MASTERPIECE OF BRITISH BRIDGE-BUILDING, AND THE GREATEST STRUCTURE IN THE WORLD.

saving on 976 millions of tons of freight moved in 1900. These larger cars carry double the paying load of the old ones that they have superceded, and more powerful engines draw more cars in a train. This increase of weight of rolling stock has led to the renewal of the 63,000 old bridges by stronger and heavier ones. This demand has brought into existence many bridge-building companies, and they can well afford to equip themselves with the best labor-saving and accurate-working machinery, regardless of first cost, as they know it

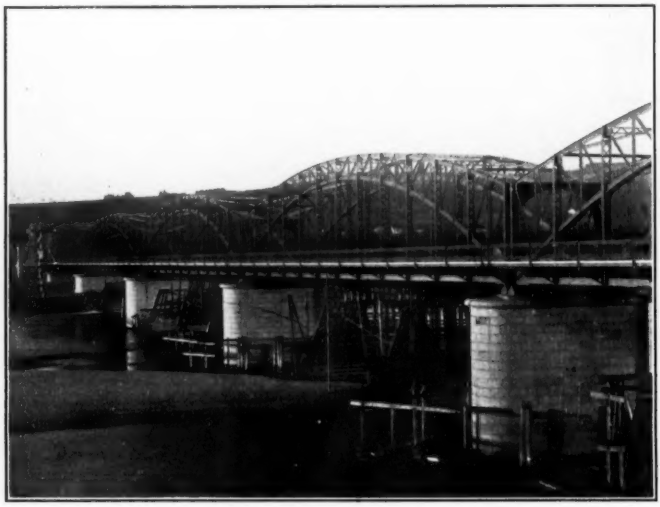


THE KINZUA VIADUCT, ON THE ERIE RAILWAY, NEW YORK STATE. ONE OF THE GREATEST VIADUCTS IN THE WORLD.

This was one of Mr. Clarke's most important works. The views are taken during the recent reconstruction, necessitated solely by the tremendous increase in weight of American engines and rolling stock. In the lower picture the relative weights of the old and new constructions are well suggested. The photographs are presented by the courtesy of C. R. Grimm, C. E., engineer of reconstruction.

would seldom if ever lie idle. European bridge builders are not in this position. Trains have not increased in weight as they have in America. The old bridges answer their purpose, and the demand has been chiefly confined to new ones. Bridge building is merely an adjunct to other business, and possibly the owners are wise in not investing much capital in special tools.

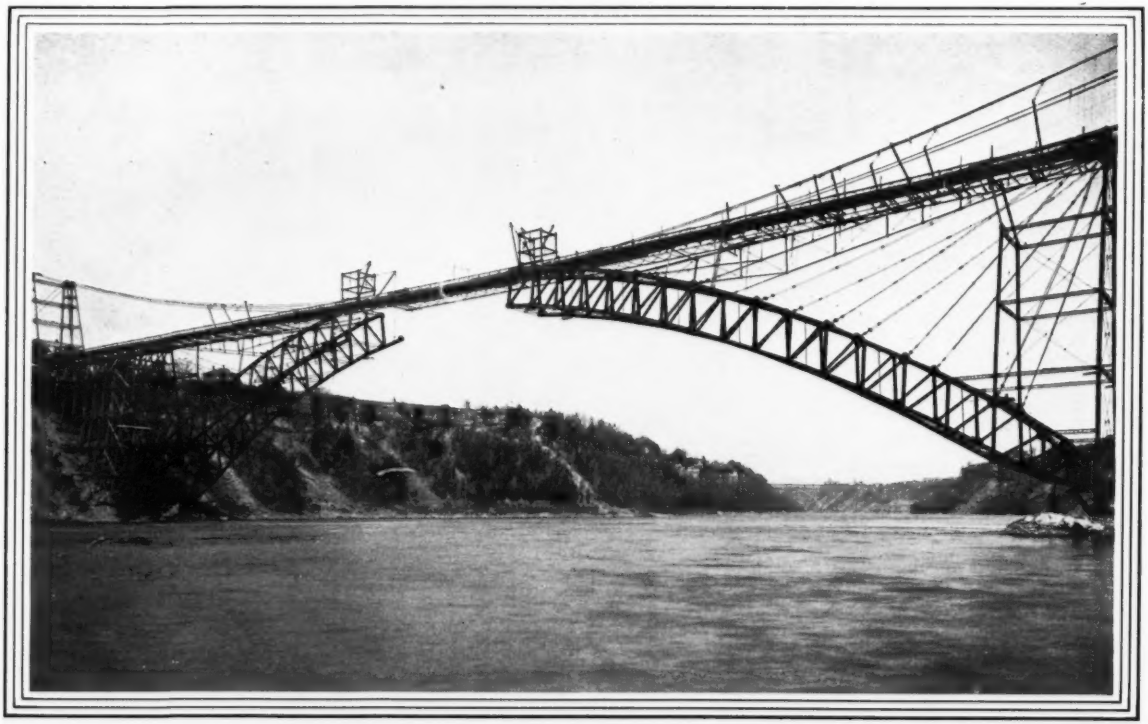
One of the most accomplished of American bridge constructors, Mr. J. V. W. Reynders, superintendent of the Penna. Steel Company at Steelton, Pa., has kindly allowed the writer to quote from a letter on this subject:



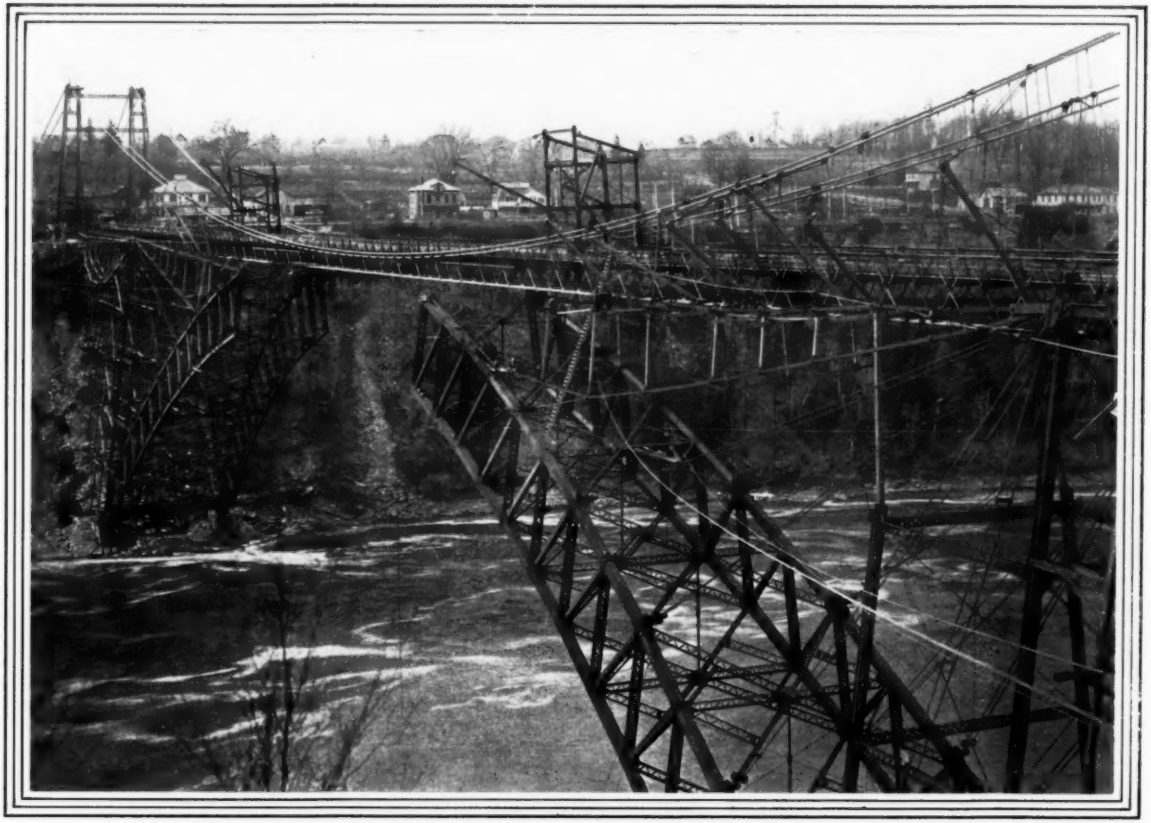
AN EXAMPLE OF CONTINENTAL WORK THE BRIDGE OVER THE INN, CONNECTING BRAUNAU IN AUSTRIA AND SIMBACH IN GERMANY.
By courtesy of Gustav Lindenthal, C. E.

"Some of my impressions in regard to the causes which have resulted in the supremacy of American bridge builders, which impressions are partly the result of my visit to French, German and English shops during the summer of 1900, are as follows:

"As to general causes, our almost unlimited home field has entailed in the past a strenuous domestic competition beyond European conception. As a result, when the long-overdue trial of strength came, we were as much surprised no doubt as our competitors at our superior facilities to manufacture promptly and cheaply.



THE GREAT NIAGARA ARCH—THE LONGEST STEEL-ARCH SPAN IN THE WORLD. BUILT TO REPLACE THE SUSPENSION (HIGHWAY) BRIDGE, WHICH WAS NO LONGER ADEQUATE TO THE TRAFFIC.

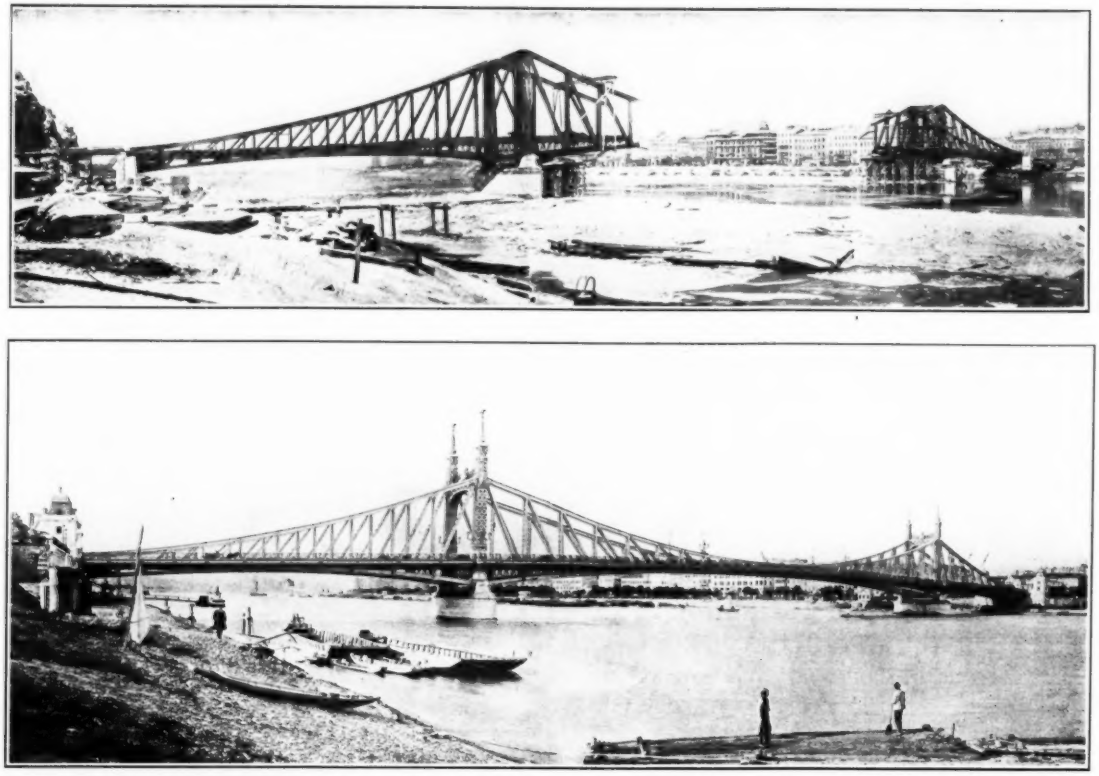


VIEW TAKEN DURING CONSTRUCTION OF THE NIAGARA ARCH, SHOWING THE METHOD OF PUSHING OUT FROM BOTH ENDS WITHOUT THE USE OF FALSEWORK.

"The development of the industry was much aided owing to the fortunate relations existing between American consulting engineers representing the purchaser and the works. Our excellent specifications were developed largely by the former, while the works management, frequently composed of young and enterprising men, kept the manufacturing facilities well abreast of the increasing demands of the specifications. A broad-minded publicity insured a practically uniform growth, not only in the development of the specifications, general designs, and details of construction, but also in the mode of manufacture and economic erection.

THE HOOGHLY RIVER BRIDGE. ENGLISH CONSTRUCTION.

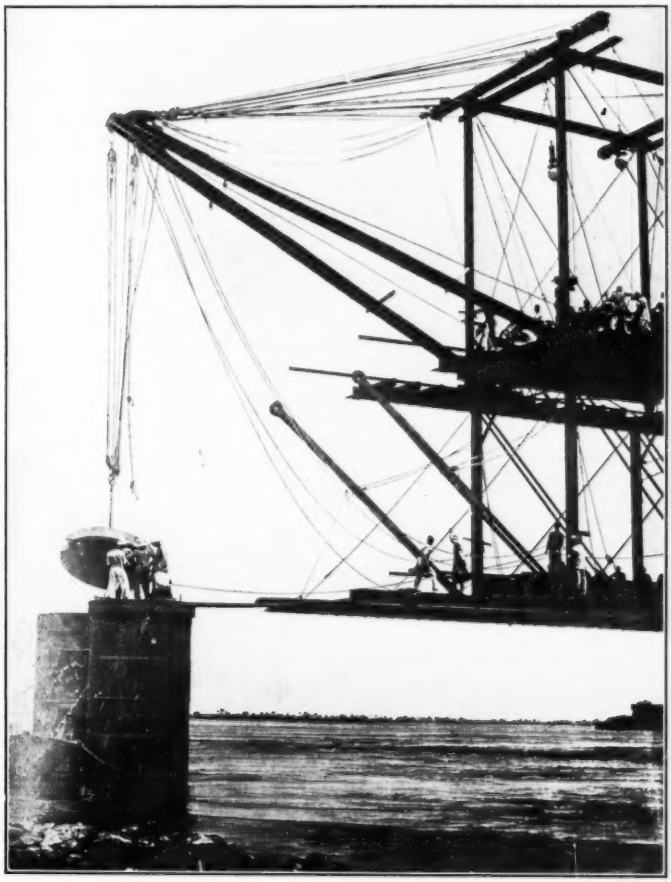
"The disinclination of European managers to invest in new appliances has become an old story, but nothing short of a personal visit to the works can disclose the amazing methods still in vogue in France, England, and, in a much lesser degree, in Germany; the manufacture and erection of bridges resolves itself largely into a 'Handling Proposition.' Much as could be said of the convenient and substantial character of our machine tools, the first problem that presses for solution is that of handling pieces, weighing many tons, from one tool to another. And this problem properly solved insures not only



THE FRANCIS JOSEPH BRIDGE AT BUDAPEST, DURING CONSTRUCTION AND AS COMPLETED. A FINE EXAMPLE OF CONTINENTAL WORK.

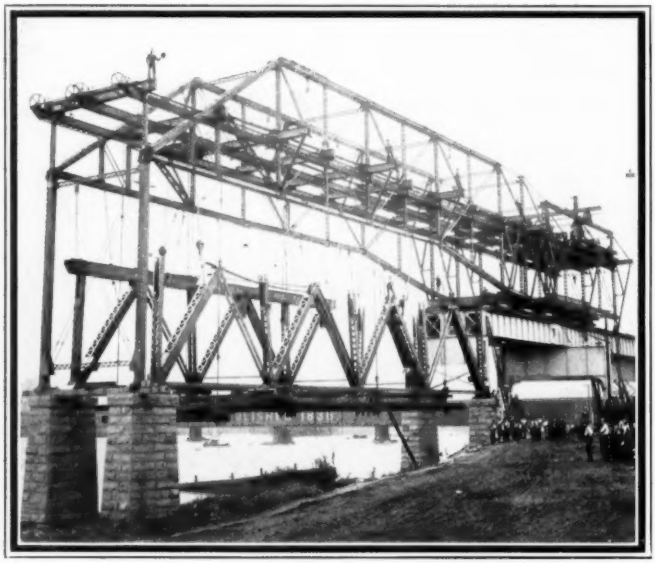
By courtesy of Gustav Lindenthal, C. E.

an immense reduction in the shop labor, but brings with it an increased out-put, as against which the general and office expense remain nearly stationary. The electric traveling crane is, without doubt, the most potent individual factor in the success of American



BUILDING THE ATBARA BRIDGE. THE TRAVELER PLACING THE CAP ON A PIER.

shops, next to which I would mention the application of electric motors for driving single or grouped machines, doing away with shafting or belts, which interfere with the operation of traveling cranes, and at the same time, enabling tools to be placed in such



TRAVELER USED IN TERMINAL IMPROVEMENTS OF C. & O. RY. AT RICHMOND, VA., U. S. A.
Total length, 213 feet 8 inches; overhang, 142 feet; base of rail to top of chord, 42 feet.
American Bridge Co.

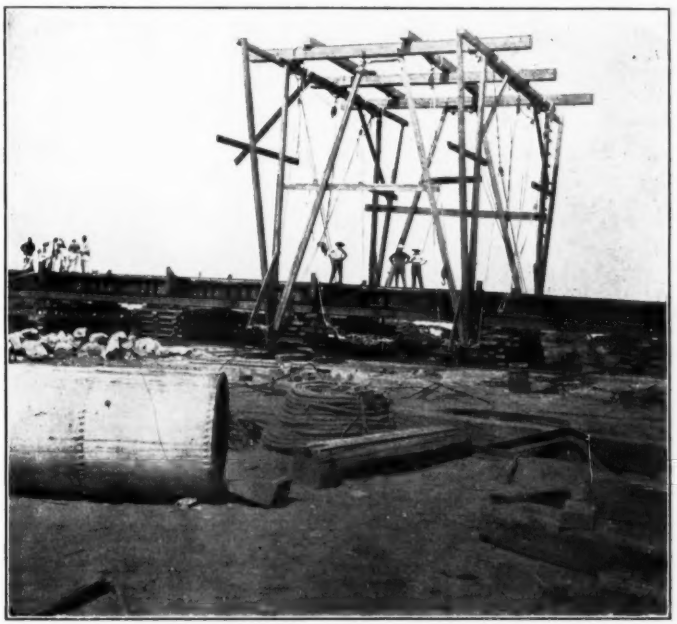
positions that long pieces can generally be kept parallel with the direction of the general shop travel.

"In the French shops visited by the writer, handling was done entirely by main strength and awkwardness, not a single traveling crane being in evidence. Nor did a single tool impress itself on his mind that would not be consigned to the scrap pile with us. English shops are somewhat in advance of this state, and while in Germany the nearest approach to American practice is found, the scale of expenditure for equipment is much reduced. As a rule, German managers fully appreciate the state of American art of manufacture. They are restricted generally, owing to the disinclination of works owners to invest lavishly in plant, and, in point of fact, it may be doubted whether the general volume of business in Germany would enable any one modernized plant to secure enough business to keep things hustling the year round. The aggregate annual out-put of the four largest bridge works in Germany is approximately 32,000 tons, which is equivalent to the tonnage of a single American shop of the first class. In conclusion, I would call attention to one other ele-

ment of our success—that is, the ability of American railroads to handle long and heavy pieces. As a result, American designers enjoy great latitude as to dimensions of single members making up a bridge, and this in turn has its effect on the design of bridge shops which are suited to handle pieces weighing in some instances as high as eighty-five tons, and other pieces such as plate girders having a length of one hundred and twenty feet or more."

I am indebted also to Mr. Charles Macdonald, vice president of the American Bridge Co., for valuable information on this subject.

This condition of European bridge shops recalls to me the condition of those American shops which were in existence in 1870. The American bridge engineer of to-day has few of the difficulties that were overcome by the early designers of iron bridges. The mathematics of simple forms of bridges was understood in 1870, but the proportioning of details had to be worked out by each man for himself. Every new span was a new problem. Now, the propor-



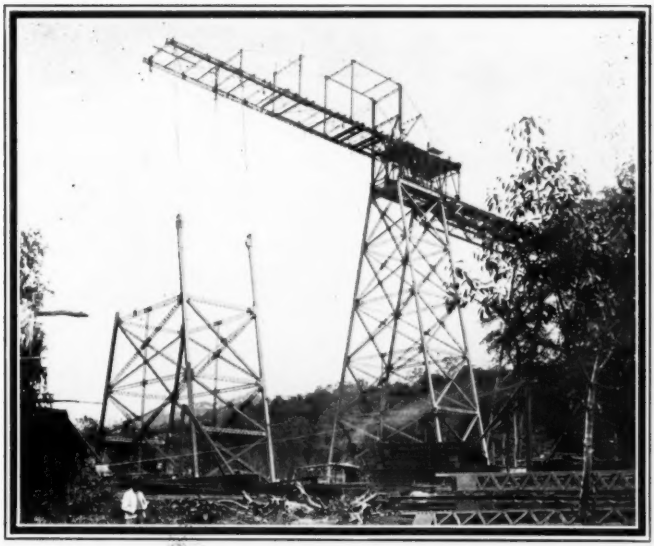
WORK ON THE ATBARA BRIDGE. THE TRAVELER.
Erected by the Pencoyd Iron Works, Pencoyd, Pa., U. S. A.

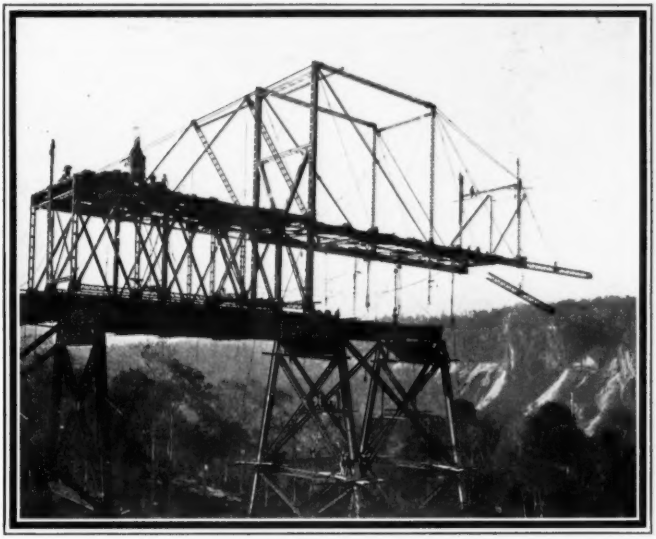
tions of lengths of span to height, and the length of panels, have been fixed by practice. Connections have become so far standardized that the duplication of parts can be caried to its fullest extent. The proper spacing of rivets is now better understood. Designs are so made that machine tools can make every part. Great accuracy is attained and the sizes of parts have increased. The bridge is never assembled until it reaches the staging or false works, and it comes together like the parts of a clock. Much of it is fastened together by

THE ATBARA BRIDGE ABOUT HALF COMPLETED.

power rivetters. Except in a few instances, the American bridge builders know that the designs of the engineer of the purchaser will be similar to those that he has been in the habit of working under, and no abnormal features will be embodied. Everybody now knows what everyone else is doing.

The foreign engineer, with some notable exceptions, is somewhat isolated in his own office, and solves each problem by requiring strength and durability only, and without much attention to the use



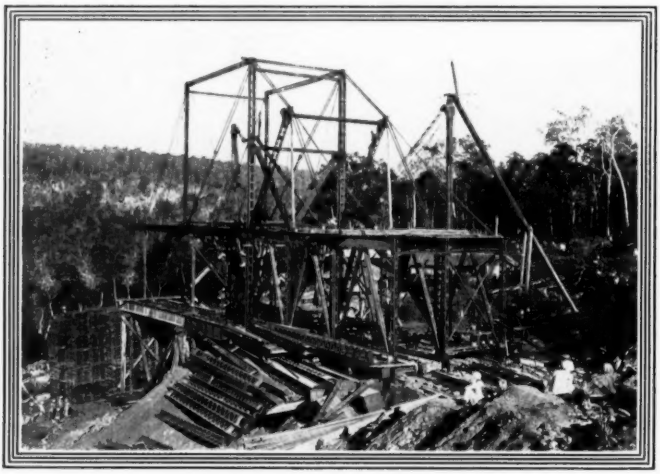


ERECTION OF THE GOKTEIK VIADUCT BY THE PENNSYLVANIA STEEL CO., OF STEELTON, U. S. A.

The cantilever traveler, in the upper view, is being employed in the erection of the next pier required by the progress of the work. Falsework is thus dispensed with. The lower view shows the traveler at closer range.

of such details as ensure economy of construction and rapidity of erection.*

It is a frequent complaint in the English press that the sections of metal called for by their engineers are unusual and not kept in stock. They complain that the details are often so complicated that duplication is impossible, and that sometimes hand labor only can be had. They complain that the economy of time in erection is not duly considered. A late notable example is of a bridge in Australia, where all the raw material was hauled seventy miles to the site, where shops were built for this bridge only. One can imagine the cost of such a

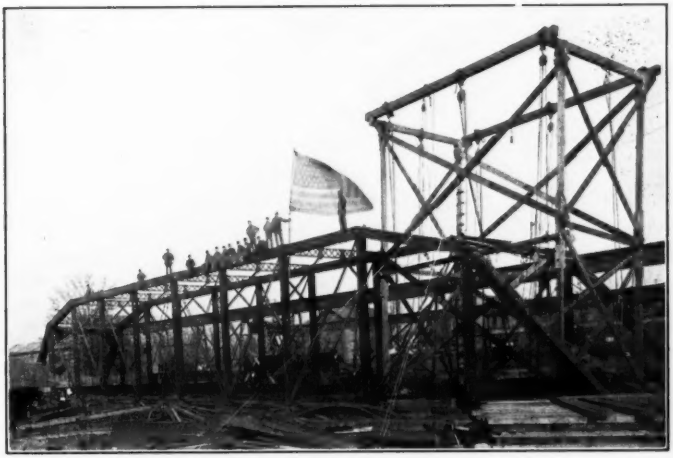


THE GOKTEIK VIADUCT. MATERIAL ON THE GROUND.

bridge. In another case the engineer required that the bridge should be all rivetted together complete in the maker's yard in England, then cut apart and shipped, and rivetted a second time on the scaffold.

The results of these different methods of operation is seen in the following statement of three important contracts captured by American bridge builders from the native competitors. It should be observed that these contracts would not have been so awarded unless the engineers of the purchasers has first satisfied themselves that both the steel material and the workmanship of the Americans were quite as good as, if not better than, those proposed by home constructors.

* "In this country it has been the custom since iron bridges were first constructed, for each engineer to design his own bridges, with the main object of making them somewhat different to every other engineer's design."—*London Engineering, June 9, 1899.*



AMERICAN-BUILT HIGHWAY BRIDGE FOR HOKKAIDO CHO, JAPAN.

Length 200 feet, width 20 feet, maximum height 25 feet. American Bridge Company. In this case the buyers insisted upon complete erection before shipment.

AMERICAN FOREMEN AND NATIVE RIVETTERS AT WORK ON THE GOKTEIK VIADUCT.

DESCRIPTION OF STRUCTURES.	WEIGHTS, GROSS TONS	NAMES OF ENGINEERS.	NAMES OF CONSTRUCTORS.	AMERICAN. COST PER TON	AMERICAN. TIME.	ENGLISH. COST PER TON	ENGLISH. TIME.
Atbara Bridge, Africa, 7 spans of 147 feet.	622	Sir Douglas Fox.	Pencoyd Iron Works.	£10.13.6	Construction 6 weeks, erection, 8 weeks; 14 weeks.	£15.15	First span in 2 months; remainder, one span every 3 weeks.
Gokteik Viaduct, Burmah. 2,260 ft. long by 320 ft. high.	4,332	Sir Arthur Rendel.	Penna. Steel Co.	£15.	1 year.	£26.10.	3 years.
Uganda Viaducts, East Africa.	7,000	Sir Arthur Rendel.	American Bridge Co.	£9.5 £18.	Delivered 10 months. Erected 46 weeks.	£15.5 £21.12.6	Delivered 60 weeks. Erected 130 weeks.

It goes without saying that proper specifications and careful and rigid inspection must insure this result. The engineer's plans were made to allow of the use of sections in stock, the details were of the American type; and rapid erection was assisted and not hindered. Everything was of the most complete modern type.

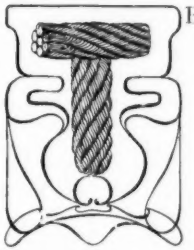
Great credit is due to those eminent engineers—Messrs. Fox and Rendel—for their liberal and advanced views, without which a fair competition could not have been secured.

The interesting question for English, French, Belgian, German, Austrian and Italian bridge constructors is—how to get back this business from their American competitors? A few large works may learn to make steel at as low cost as Americans do. To do that they must have the courage of Carnegie, who throws into the scrap heap a million of dollars of machinery that has become a little antiquated. They can observe methods of design and imitate them, as some progressive American manufactures have done. But how shall they get the constant market for bridges which has enabled American bridge companies to invest vast sums in labor-saving machinery and other appliances?

It seems to me that there is but one way, and that is to stop spending so much money yearly on armament, and apply it to the reconstruction of their railways.

VILLAGE COMMUNITIES OF THE FACTORY, MACHINE WORKS, AND MINE.

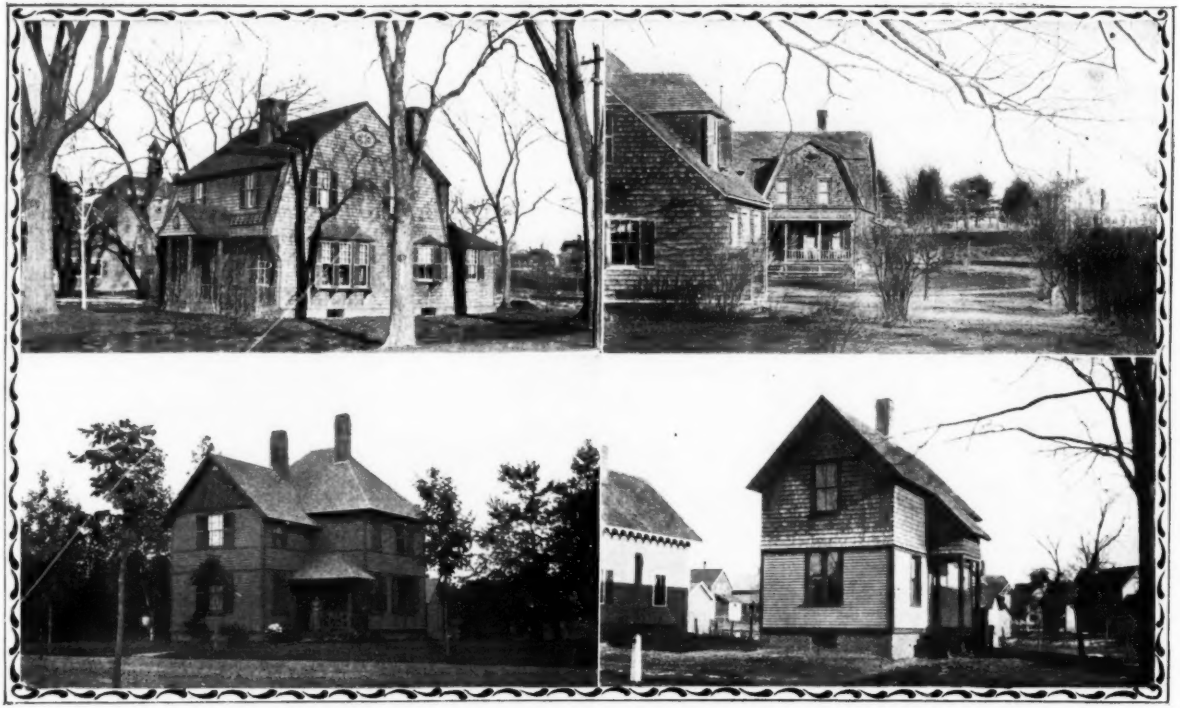
By Charles Buxton Going.



TEN years ago this month—in April, 1891—I contributed to the first issue of THE ENGINEERING MAGAZINE a short study of "The Second Summers of Village Communities." It dealt with some of the physical problems early presenting themselves to a little town just reaching the stage where complete individualism of the people must be modified by some common action on matters of common necessity, and where the engineer is perhaps first called in to serve the community in matters of water-supply and sanitation.

But if sociological conditions have imposed engineering problems, engineering advance, on the other hand, has given rise to social questions and movements which are of the most pressing importance. The ten years just past have been characterised above all by mechanical progress and, as its corollary, by centralisation of industry. The factory system has drawn the working community toward foci, with ever-increasing intensity. Economy of production—the great all-controlling influence in the modern material world—requires the concentration of power in huge units, and about these cluster ever-growing and ever-denser swarms of machine tenders—workers of every grade. The movement goes on with almost unthinkable rapidity, but pace by pace with it move the conditions of labour, of life for the labourer, and of relations between workman and employer. Mechanical production—to use the accepted phrase—is working a revolution in economic affairs, in the distribution of industry, in the balances of trade, and in national politics and precedence. It is also working a revolution in social conditions and relations.

It is no wonder that many earnest minds shrink from the realisation of this ceaseless onrush, and wish that it might be stayed. And yet it is not mere optimism to hold that the outcome is for good, and continually for the better. Viewed in the large, the last century has done more to free the body and the mind of labour—to reduce physical toil, increase its reward, enlarge opportunities, and open the way to a



HOUSES IN LUDLOW, MASS., U. S. A.—THE INDUSTRIAL VILLAGE CONNECTED WITH THE WORKS OF THE LUDLOW MFG. CO.

The upper left hand picture shows an eight-room house; beside it is a view of the rear yards, showing their neatness. Below are a six-room cottage, on the left, and a four-room cottage—the smallest dwelling built by the company—on the right.

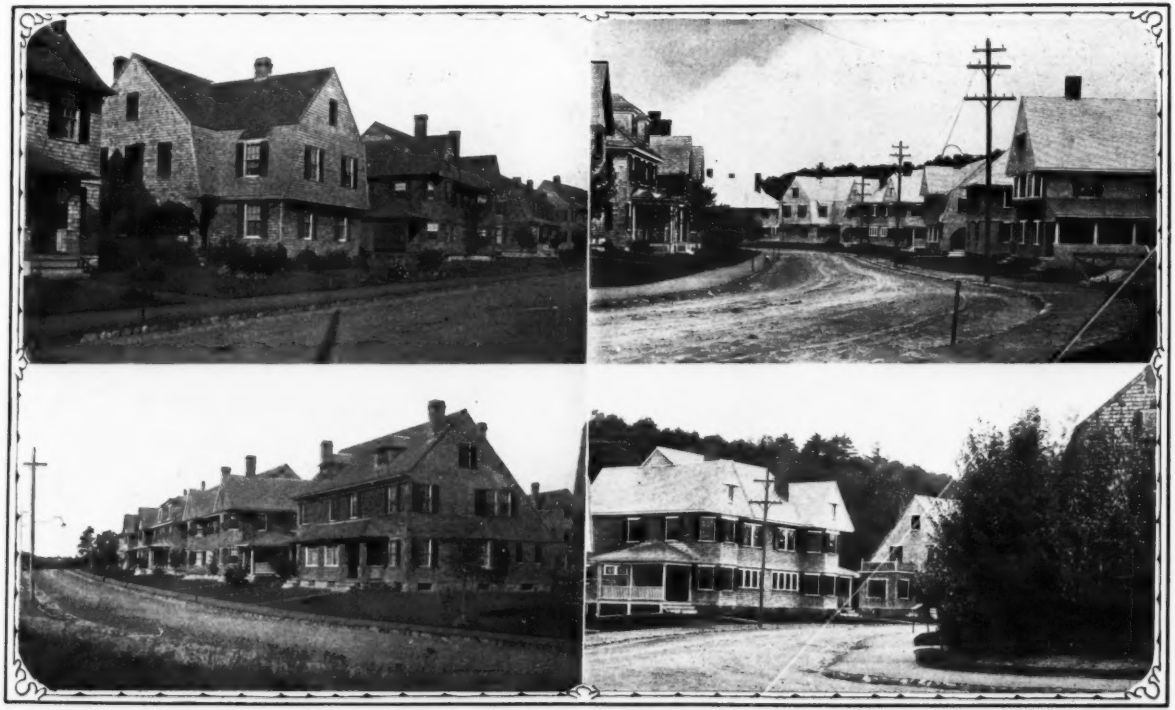
larger sharing in the higher things of life—than all the centuries which went before. The future may be most safely judged from the past. What the introduction of machinery began, the enlargement of its use will continue.

It needs time for so large an adjustment, and the period of adaptation to new conditions is a trying one. As, in the factory management, system and organisation must take the place of proprietary oversight and direction, so between employer and employee a new basis of relation must be established. The close personal contact between proprietor and workman, which belonged to the domestic and semi-domestic era of manufacturing, must give way to something else—some counterpart suited to the new order. But that it should give way and nothing take its place, would be as fatal as that management should lapse into chaos, because the owner could no longer personally direct every detail of a mammoth plant. The complex human element in a great manufacturing works needs the more intelligent provision, in even greater degree than its complex motive power and machinery need more skilful care than the little water-wheel of the first factory. But modern civilisation—at least in the enlightened industrial countries—rejects the paternalism of early days, even if modern conditions do not make it impracticable. Not the least characteristic result of the age of machinery has been the development of individuality in the worker. Enlightened self-interest demands that the employer shall consider the welfare and comfort of his men, but reason, justice, and sympathetic comprehension must be the elements of the relations—not patronage on the one side, nor unmanly dependency on the other.

It must be admitted that the perception of the employer's interest in the well-being of employee has been rather lately regained after a period of indifference to, or perhaps active rejection of, the idea that there should be—must be—such an interest. The cycle is swinging round again to a phase somewhat modified, possibly not always enough modified, from that displayed in the old days of proprietor and apprentice, when the physical and moral charge of the labourer was assumed by his master. Perhaps a prototype still closer, because on a scale more nearly equal, might be found in the great iron works of the early half of the nineteenth century. In the Black Country of England, and in the Ohio valley in the United States up to the time of the civil war, these great establishments were the largest existing aggregations of manual workers and heavy machinery. The very conditions of their being marked them out for isolation and necessary self-dependence. The mine and the furnace created the community.

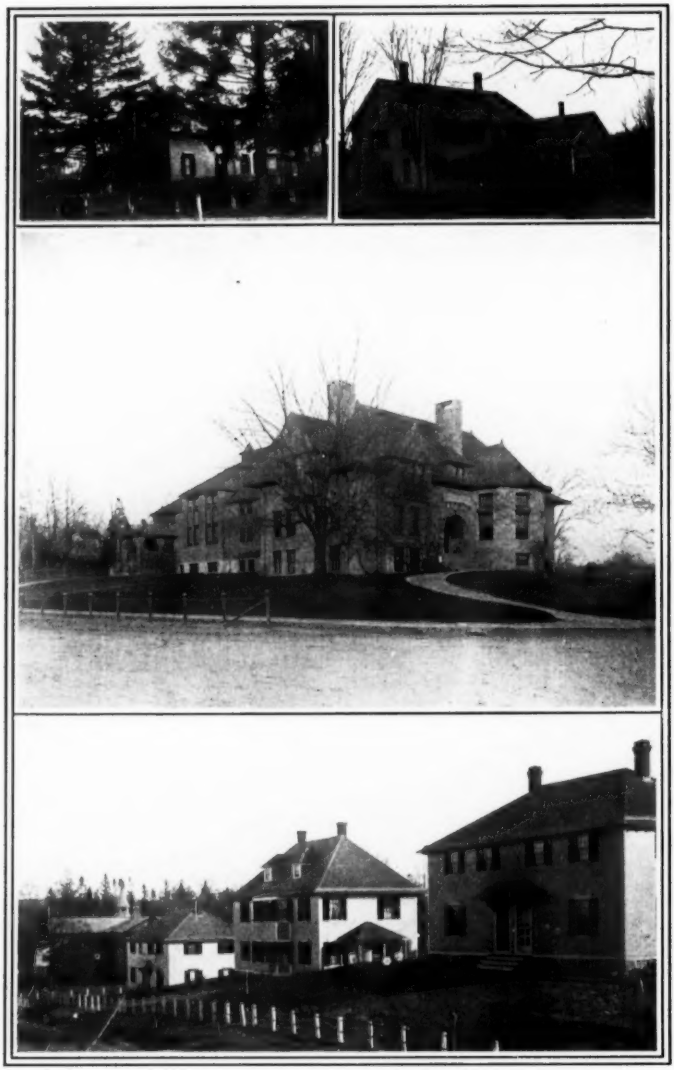
The owner of the plant was very generally, from the nature of the enterprise, owner of most of the adjoining land. He alone had sufficient facilities for securing and distributing the needful provisions and supplies. He was employer, landlord, health officer, lawmaker, magistrate, merchant. The workman, while separated from his employer by a wider gulf than now, was more dependent upon him. The system was almost patriarchal—quite feudal. The ironmaster was a petty lord and a political power of no small importance; for while internal conflict was by no means lacking, especially when the feudal baron had not the wisdom to be beneficent, the community was one in its interest in outside affairs. The often remote situation and peculiar surrounding conditions of the mine, together with the semi-military discipline which must characterise its conduct, favour the persistence of many of these conditions to the present day. With the growth in importance of factory plants, and their necessary location in outlying situations where they may have room to grow and space enough for their dependencies, there is a marked and rising tendency toward the establishment of somewhat similar relations, modernised and improved, between the factory management and factory operatives. Wisely directed, it has vast possibilities for bettering the surroundings of the working classes and creating a strong, practical, concrete political influence for sound economic legislation and the promotion of national welfare.

There is no danger of the pendulum swinging back too far. Twentieth-century social ideas are sufficient to hold the balance. The conceptions of constitutional and individual liberty are too firmly planted and broadly branched to allow paternalism to grow under their shadow. But it would be unfortunate to see efforts, well-conceived and meritorious in the main, meet a check which would reflect on other budding enterprises, simply because they did not sufficiently recognise the boundary between healthy fostering care and encouragement and an unwise even though benevolent "bossism," or an intolerable attempt to control the man because he is a workman. Probably no more carefully devised or thoroughly worked-out plans for a factory community were ever put into effect than those which took shape in the town of Pullman. Possibly the model was excellent. But individual lives cannot be stamped into uniform pattern nor made interchangeable, and the Pullman experiment, instead of preventing trouble, aggravated one of the worst strikes known in the history of America's labour wars. The way to a sound and healthy life in the factory community lies well between the two extremes of apathy and indifference of the management on the one side, and an over-interest,



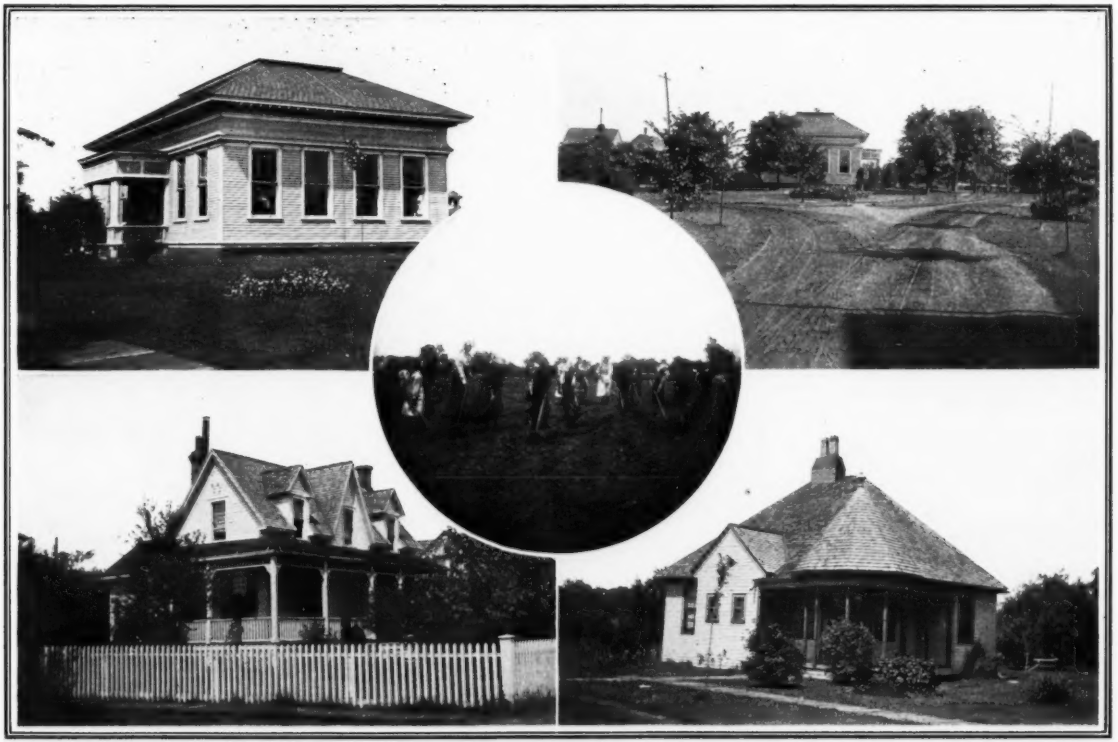
VIEWS IN THE DRAPER COMPANY'S MODEL VILLAGE OF HOPEDALE, MASS., U. S. A.

The yard of the house in the foreground of the upper left-hand cut received the first prize in 1900. The other views give an excellent idea of the class of dwellings and the neat and attractive streets.



FEATURES OF THE PEACE DALE MANUFACTURING SETTLEMENT.

The central view is the Hazard Memorial Hall, built by the owners of the company for the use of the village and containing library, gymnasium, baths, class-rooms, and hall. The other pictures are of operatives' cottages. The school-house is in the background of the lowest picture.



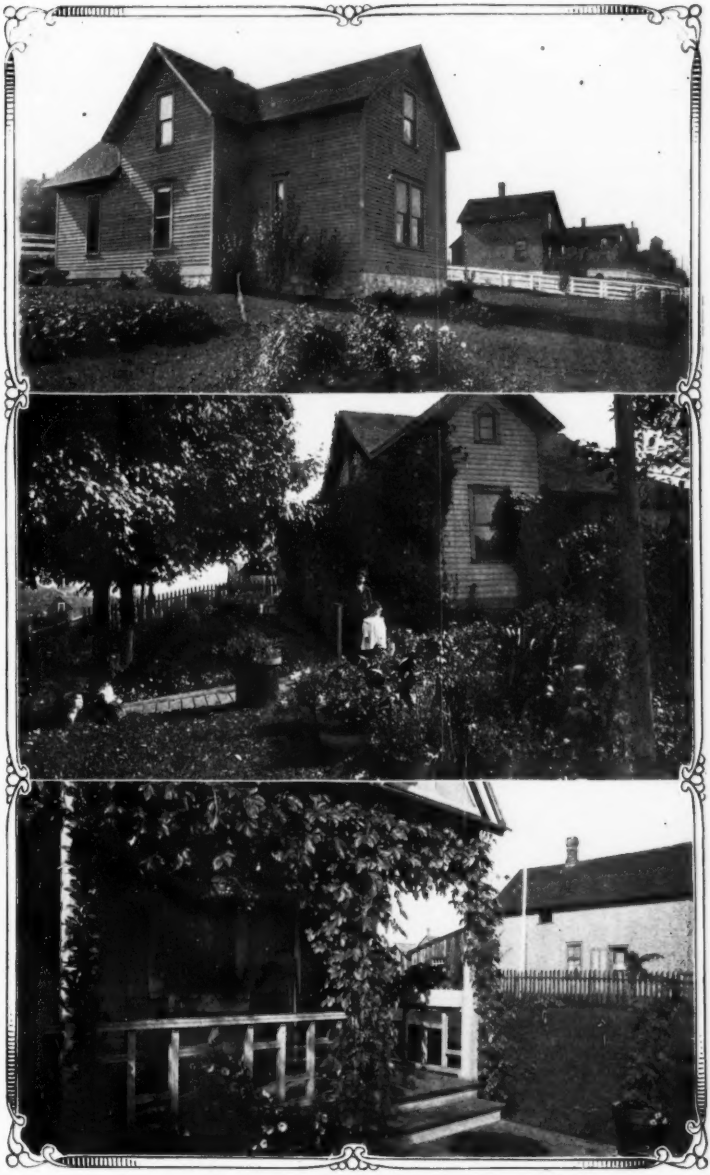
THE CO-OPERATIVE VILLAGE OF LECLAIRE, FOSTERED BY THE N. O. NELSON MFG. CO., ST. LOUIS, MO., U. S. A.

On the upper line are the public hall (on the left) and school house (on the right); below are typical workmen's cottages. In the center is the children's gardening club at work.

coupled with chafing restrictions, on the other. But that the happy mean can be found, and when found will promote mutual satisfaction and prosperity, is amply shown by a rapidly increasing number of examples in the manufacturing world.

The most obvious step in protecting a factory community through the critical times which come with increased pressure of intensity on its life, is one whose simplicity puts it within range of every establishment, large or small. It is confined in its exercise within the factory, and is simple attention to those matters of hygiene and comfort which the workman can not provide for himself, but which are essential to physical well-being (and hence to high efficiency) and to the promotion of good personal habits and self respect. Such matters are proper ventilation and heating—discussed elsewhere in this number by Mr. Allen—proper facilities for washing, provision for changing clothes, and decent sanitary arrangements. Coupled with these is the provision for bath-time during working hours without loss of wages —a tacit recognition that conditions of employment which bring dirt and discomfort should provide also for its removal. Next come provisions for providing meals, or supplementing those which the workmen bring with the nourishing or appetising things which can not be carried, or which the situation of the works or the shortness of the meal-time make it difficult and unduly expensive to procure. Something can be done in this way, also, toward directing the employees' attention to more nutritious and wholesome dishes than they have been accustomed to provide for themselves. Beyond this again are the opportunities for mental improvement through the establishment of club-rooms, assembly rooms, lectures, libraries, and other means of education in the subjects most helpful in the men's work. All of these are well-recognised and largely practised, and readers of Mr. Patterson's article in the Works Management Number of THE ENGINEERING MAGAZINE, in January last, will recall the many successful instances he cited and the forceful unanimity with which Messrs. Patterson, Orcutt, Bell, Canniff and others urged the practical value of thus increasing the employee's helpfulness and efficiency and establishing a community feeling in the works by a manly regard for the workman's intelligence and proper surroundings.

But it is outside of the factory walls that the workman spends most of his life, and here the interest of the employer more rarely follows. This is an oversight all the more grave because, with the growth in size of individual plants and the increase in the number of works employing thousands of employees, the distinctly "factory com-



MINERS' HOMES, CLEVELAND CLIFFS IRON CO., ISHPEMING, MICH., U. S. A.

The lower and middle views are of first-prize cottages for the season of 1900; the top shows a house which took second prize for the best-kept premises the same year.

EFFECTS OF THE ENCOURAGEMENT OF EMPLOYEES' INTEREST IN THEIR HOMES, NATIONAL CASH REGISTER CO., DAYTON, O., U. S. A.

The cut on the right shows the results of vine-planting; on the left, below, is a view of the back yards of employees' houses. Above that is a single yard, which took the Ladies' Home Journal prize in 1900 for the "prettiest back yard in America."

munity" is becoming a larger and larger element in economic and political influence. If, by patient exercise of a due and consistent regard for the workman's welfare, the employer establishes a feeling of mutual regard and sympathy, much of the misunderstanding between capital and labour will be effaced and no demagogue will dare —or should he dare, will succeed—in playing upon the suspicions of one side to enable him to fleece or force the other. United, they will be an irresistible power for wise and stable economic legislation.

It is therefore, to repeat, by a grave oversight that the manufacturer has not oftener considered the employee's interest parallel with his own in building up his works. Within city limits, this is perhaps hardly possible; but there general conditions govern the cost of living and the employer can scarcely, without meddling, enter into his employees' arrangements in that regard. But it is growing more and more common for large works to move, or to be established, in rural and semi-rural districts, where land and taxes are low and there is room to spread as the growth of business may demand. Under these conditions it has been altogether too common—at least in the United States—for the proprietor to make the best arrangements he could for himself and leave his workpeople to get what they could after his bargain was tightly closed. It is not at all uncommon for a factory site to be given to the owners of the business, free of any charge and often free of taxes for a period of years, in consideration of their locating in a certain place. The neighbourhood gains from the increased population and the increased chance of employment for its own people; but the employees practically pay the bill for the site, for all ground nearby is advanced greatly in value, houses are built in certainty that they will be absolutely needed by the incoming army of workers, and local landlords and lodging-house keepers put up their prices to the limit. I have known personally of men who made their living by dealing in factory sites—buying up or securing options on available properties, getting some large manufacturing plant, under good inducements, to take enough for their own purposes, and making his handsome profit out of the adjoining ground—the higher values being paid, immediately or indirectly, by the workingmen and their families.

In a case of this sort, where the men's interest is diffused and almost intangible—at least, incapable of being concentrated into a unit which can operate with the factory management to joint advantage—it certainly seems as if it would be only reasonable and just for the employers to act as trustee of the tacitly confided interest of their men, and to secure for them the same advantages they get for themselves. In

this there would be no paternalism, but simply the regard which an active partner might show for an unrepresented one—simply the regard which, it is now recognised, a controlling stock interest should show the other shareholders. And here the question is not one of abstract principle but of practical relations, for the management and the employees must continue to work together, and everything that makes life fuller and more satisfying to the workman tends directly to the advantage of his work and of his employer.

The after adjustment might be determined as good judgment and the special conditions direct. The main point is that the development of the very desirable factory-community spirit can not well be fostered by starting with a real-estate deal in which capital takes a virtual profit at the expense of its co-operative element—labour. As Mr. Shuey says:* "The experience of Pullman and similar efforts has not encouraged others to do much toward building towns owned and controlled by the company," though throughout the new cotton-manufacturing district in the southern States this is at present the custom, as it is in some leading English examples—notably, I believe, the Cadbury Brothers' village at Bourneville and the Lever Brothers' settlement at Port Sunlight. In New England are to be found some of the best-established examples in the United States—those whose soundness of basis is evidenced by the length of their existence and their satisfactory results to both sides. One of the most clean-cut and definite instances, perhaps, is the village of Ludlow, Mass. The company built the water works, gas works, electric-light plant, churches, and school houses. Their general policy with regard to the employees' residences can best be given in the words of Mr. J. E. Stevens, agent of the company:

"Our efforts have been to give every family a complete home, even if it has but four rooms, which is the smallest cottage we build. We avoid as far as possible building anything in the way of blocks, and what is known as the usual mill-tenement block we have long since discarded. When we first began building the modern type of cottage, or about twelve years ago, it was our policy to sell to any of our operatives who cared to buy, and as a matter of fact we did sell several cottages with lots of about one-quarter acre. We sold the cottages for about the cost of building, calling the land nothing, and making easy terms of payment. This plan, however, did not work out successfully for the reason that rules drawn up to promote the health and comfort of the community at large could not be enforced against individual holders. For this and kindred reasons we have ceased to sell cottages and, in fact, bought back at a premium those we sold. Our rents are made as low as can consistently be done, and are much lower than the prevailing rents in this neighborhood. It is our intention

* Factory People and their Employers. E. L. Shuey. Lentilhon Company, New York.

to offer prizes for the best-kept homes and gardens, for while many tenants take an interest in their surroundings, others are wholly indifferent and can with difficulty be got to co-operate in the protection of shade trees. In designing our cottage homes, we have limited our study almost wholly to the inside: many of these we believe are models of comfort and convenience. We have not made an effort to obtain striking or even showy outside effects, but have rather adopted plain exteriors, with a view to minimum of expense for repairs and maintenance."

Another strikingly successful factory community in the State of Massachusetts is Hopedale—a small place of about 2,000 inhabitants, whose only industry is operated by The Draper Company. It is, in fact, a typical example of the factory village. The tract of ground on which it stands was laid out at the company's instance by a prominent landscape architect, and sidewalks, sewers, and other improvements were put in. The principles governing the relations of the company to the community of its employees are thus defined by the assistant agent, Mr. F. I. Dutcher:

"We do not give special encouragement to our workmen to buy their own places. Hopedale is a very small town and our company operates its only industry. It is necessary for us to furnish tenements to a great many of our people, and, on the other hand, those employed by us owning their own places, in case they should leave our employment, are not as well situated as they would be in or near a large town or city if left with a piece of real estate on their hands. We do make an inducement in the way of rentals, in the fact that our rates are based upon an extremely low percentage of income, so low, in fact, that no outside parties build tenements for this purpose.

"To encourage care of the premises about the houses of our employees, we offer every year premiums covering the general outside conditions both of the front and back yards, and shall distribute for the coming season $300 in this way. We have found after an experience of quite a number of years in this direction, that the average condition of the premises has greatly improved.

"Two boarding houses are owned by our company, and are operated independently by people who rent them, but we do reserve the right to limit the price to be charged for board and to keep a certain amount of supervision on the way in which things are run.

"The local government in Hopedale is the same as in any Massachusetts township. While our people interested in and owning the works of this company are in a way equally interested in the town, its boards and officers are elected by people having a right to vote, and without the least regard to property ownership

"As far as the writer is aware, there is a good understanding between the employers and employees in this community. We have had absolutely no labour difficulties for many years, and none whatever that were at all serious."

The Peace Dale Manufacturing Company, of Peace Dale, Rhode Island, is yet another New England example of the distinctive factory community, and one in which personal, family, business, and village

interests have been linked together for nearly a century. The company built the town hall, library, and village church. The Hazard Memorial, shown in the center of the grouped views on page 64, contains, library, gymnasium, baths, class rooms and hall, and was built by the owners of the company for the use of the village. In this case, the treasurer of the company writes, the employers build houses for rent to the help, and also encourage them to build and own their own houses by loaning money and selling land on easy terms. In some cases operatives have not only acquired their own houses, but have secured additional houses and themselves become landlords.

One of the most characteristic of American industrial settlements is the co-operative village of Leclaire, connected with the factories of the N. O. Nelson Company, near St. Louis, Mo. It would be impossible to set forth its constitution or its effects more forcibly than in Mr. Nelson's words. In a brief magazine article published a few months ago in "Our Day," he said:

"It is a wretched arrangement by which men are huddled together in ugly factories. We have tried to make the factories attractive as well as healthy. Our days are shortened by the fact that the homes and factories are close together; no time is lost in going and coming. Every home has about a third of an acre of ground attached, thus holding one foot on the sod and one in the factory.

"Leclaire was an outgrowth of the profit-sharing system, which was adopted in 1886, and still continues. In the first ten years the dividends on wages amounted to 57 per cent. In the last four years there have been no dividends, the earnings being invested in additions and improvements. But much more important than cash dividends is the improved living, the co-operative spirit, unconsciously absorbed from the common benefits enjoyed out of the fund jointly created."

In answer to my special inquiry, Mr. Nelson writes the following fuller explanation of the policy and constitution of Leclaire:

"Leclaire is built upon a farm of 125 acres, platted into streets, blocks and lots. The land is owned by me as Trustee for the Nelson Mfg. Co. The lots when sold, are deeded in fee simple.

"There are no legal co-operative elements. Co-operation is entirely voluntary, as well in the social things as in the public things that are provided and maintained by the company. In that respect, the corporation acts as the agent for that associated number of men who do the work and who, with their families, want these public things.

"There are only two legal bodies: the business corporation, and the 'school and library association,' which holds the endowment fund and manages the school library and looks after the village public affairs. The settlement is not at all restricted to employees. At first, we built the houses for the employees on plans agreed on with them, and they paid for them in monthly installments.

Now, they build with their own money and loans from the outside, either from building associations in Edwardsville or private lenders. The company owns a few of the houses, but it has no intention of being a landlord. These few are mainly those that have been taken back from employees who left, and they are a convenience for newcomers until they get naturalized and conclude whether they are permanent residents or not.

"There are no ordinances or regulations for the village or its residents—none whatever. There is no local incorporation or authority except the county and township, and especially is there no boss. I live in the village myself, but no resident has ever been asked by me to do anything or refrain from doing anything. Every resident understands that he is as free as he would be on a farm.

"Very decidedly, Leclaire as an institution promotes sympathy and understanding between the work people and employers, and diminishes labor troubles to the vanishing point."

A somewhat less unusual policy is pursued by the Cleveland Cliffs Iron Company, of Ishpeming, Mich., but a policy which nevertheless is addressed directly toward establishing a bond of sympathy to bind the community together by other ties than those of mere payment and receipt of wages. Its most characteristic feature is the stimulus to thrift and neatness, by means of prizes given annually for well-kept premises and prettily planted gardens. Some of the results are shown on page 67. The more general relations of the company with employees are thus explained by the agent, Mr. M. M. Duncan:

"The company owns some sixty houses, which it rents to its employees at a very nominal figure; in fact, about one-half of the rates prevailing on properties owned by individuals in the city. These houses were built many years ago to attract labour to this district. Up to this time we have leased ground to those wishing to build, the rent for which is from $12.00 to $15.00 a year, in some cases exempt from taxation and in some cases the lessee pays a nominal tax.

"Of the mine employees of this city, there are about 1,125 employed by our company, about 725 by the Lake Superior Iron Company, and about 500 by the Pittsburgh & Lake Angeline Iron Company. These all live within the city limits, and all take interest in municipal government. The company retains some influence in local government, but not to the extent of holding municipal offices. The municipal officials are made up from employees of some of the mining companies and business men, as is also the city council and the county board of supervisors."

The policy of fostering the employee's interest in his home and establishing a communal interest by co-operative and competitive effort in this direction, is pursued also by the National Cash Register Company, of Dayton, Ohio, in connection with other altruistic efforts fully described by Mr. Patterson in THE ENGINEERING MAGAZINE last January. Their methods are thus defined:

"We simply stimulate and encourage our employees to beautify their homes. The company does not own or rent a single dwelling house, and does not believe in attempting to do so.

"Our work was started by organizing the South Park Improvement Association, composed of residents of South Park interested in beautifying their homes, and while it is entirely independent of the factory, we encourage them in every way possible by loaning them stereopticon slides, letting them have the use of our hall, and all facilities. In our Sunday school, which might be termed a Sunday club, we teach the principles of landscape gardening, distribute free seeds, and offer $250 annually for the best results in home beautifying."

Referring to the illustrations of the results, which are shown on page 68, Mr. Shanklin says:

"One point which we desire to call particular attention to is that these results are all obtained with the cheapest of shrubs, vines, etc., and all of them quick-growing plants indigenous to this climate.

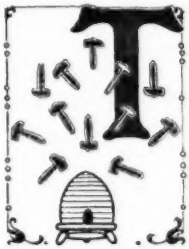
"These simply show the employees' efforts, and we have not attempted to show photographs of our own landscape gardening about the factory for the reason that it might be said that the company can afford to do these things but private individuals cannot. We want to show that this is not true."

It is not coincidence that the concerns which take these views regarding the relations between employer and employee are conspicuously fortunate in their freedom from labour troubles. The list of such concerns is lengthening at a wonderful rate, but the millennium is still far off. There are yet workmen who are "wholly indifferent and can with difficulty be got to co-operate." There are yet employers who look with disgust on what they call "coddling" the men. There are yet mine stores exacting so large profits on their compulsory sales that they more than support an unprofitable mine. Where these conditions persist, the factory community will hardly survive its "second summer." But such instances serve as foils to set off the better way found in the better-directed plants which are working toward fuller understanding and fuller co-operation between labour and capital. That this basis of mutual support should exist grows every year more vitally important. A larger and larger proportion of the nation is annually engaged in manufactures. With the increase in size of individual plants, waxes rapidly the possible damage, to the concern and the community, from the clashing of opposing parties. But organisation, which was conceived, even by its promoters, to be an institution of war, is rapidly revealing itself as the most effective agency for stability and peace. When to the reciprocal understanding and tolerance which it is bringing about between capital and labour in the large, is added the community feeling, the sense of unified interest, and the *esprit de corps* induced by an enlightened policy in the individual works, the "second summer" of the working community will be safely passed, and the way be open to stable industrial peace and the enduring welfare of both employers and employed.

THE ECONOMY OF HEATING AND VENTILATING THE MACHINE SHOP.

By Leicester Allen.

The initial number of THE ENGINEERING MAGAZINE, ten years ago this month, contained an article by Mr. Allen on "Heating and Ventilating Homes." A decade of wonderful progress in the economy of mechanical production has brought about, as one of its most striking results, a lively appreciation of the fact that the highest utility and efficiency can be secured only by surrounding the factory or shop worker with the best physical conditions—that the man, even more than the machine, must be put into a favourable environment. The following article is addressed to this highly practical idea so far as it relates to the machine-shop.—THE EDITORS.



THE word "factory," in the United States, is so loosely used to include all places wherein any specialized manufacture is carried on systematically that it will be proper in such a discussion as is herein contemplated to prescribe more definite limits to the use of the term. Boards of health have frequently been called upon to condemn the unsanitary conditions of sweat-shops, among whose sanitary sins the want of any approach to proper ventilation is, perhaps, the most pronounced evil. On the other hand there are multitudes of industries conducted in large establishments employing from one hundred up to two thousand persons, or more, in attending machines and in manual operations, in which no special provisions for ventilation exist—where they have not even been thought of as useful or profitable. So far as I have had opportunity to scan public health reports this condition of factory industry is very meagerly—indeed very gingerly—dealt with, even when, rarely, it is noticed at all.

I propose in this article to urge the propriety and desirability of giving more attention to heating and ventilation in large manufacturing plants, and to discuss very briefly general features of the problems that will arise should this desirability be widely recognized. As the question of heating is always influenced, at least quantitatively, by the amount of ventilation planned, and as ventilation is, when not mechanically effected, usually attempted and sometimes well-accomplished by currents of air set up by heating, the correlated topics of heating and ventilation of any class of buildings can not well be separated in a discussion of this kind.

As to the desirability of good ventilation in large factories, I might urge altruistic motives; but more and more the control of such establishments is falling into the hands of large incorporated companies, popularly called trusts, and I fear that altruism can hardly be put down as one of the moral assets of such capitalistic combinations. A more hopeful argument seems to be the very opposite motive, self-interest. It requires but little thought to reach the conclusion that, in a building containing a thousand human working units, a very small per cent of increase of individual efficiency would amply pay for a considerable aggregate expenditure. To get the best return for wage expenditure is the problem which every good manager of a factory has to solve. But the best can be obtained only under essentially favorable conditions. For example, I once was engaged in a crowded drawing office in executing some fine diagrams representing graphically the behavior of gases, under various pressures and temperatures to which they would be subjected during a cycle process. No special provision existed for the ventilation of this room, which was heated by pipe coils placed under windows. Those obliged to work near the windows could not tolerate having them opened on account of vicious drafts which swept in from the surface of an adjacent ice-covered river. In that room I was frequently attacked by blurred vision. A single line appeared as two, vibrating or undulating throughout their entire extent each into the other, making futile any attempts at accuracy until, by a walk in the open air of twenty minutes to half-an-hour, the disturbance of vision was removed. No doubt the work in that ill-ventilated den cost 10 per cent more than it would have done in a comfortable well-ventilated office. The wages paid there must have been at least $50 to the entire force each day, and if by reason of decreased efficiency one-tenth of the possible service was not rendered, the employers lost $5 a day during the cold season, which might have been saved if attention had been given to proper heating and ventilation.

What is true of a drawing office is equally true of an apartment filled with persons employed in more purely manual work. A listless, inattentive operative is worth much less than an alert, interested worker; and, so far as I am able to judge, nothing so breeds listlessness, inattention, and carelessness in a shop or factory as a vile atmosphere coupled with defective heating. By defective heating is meant a temperature either too low or too high for the perfect comfort of the workman in the execution of his special work. It often happens in factory industries that in the same room some are employed in work that requires much physical exercise while others are occupied in

watching or attending machines requiring vigilance rather than muscular exertion. At a temperature that is comfortable to the men actively exercising, mere machine attendants may be uncomfortably cool, and when the latter are warm enough the former may complain that they are overheated. This remark leads up to a principle in the assignment of work to different rooms of a factory, which, if systematic ventilation is recognized as desirable in factory management, will be one of the features of the problems presented.

It will be necessary to consider the temperature most favorable to progress in the various operations in special industries, and to classify the operations in this regard in different rooms in such a manner as not to interfere with other economies—such as a minimum of time and labor in passing incomplete work along for other operations and for assembling and packing. In some industries, as in cotton mills, woolen mills, and knitting mills, where the manual labour is light and consists almost wholly in attendance upon automatic machines, this classification and arrangement are already sufficiently perfect to admit of good uniform heating with equally good ventilation; but, while the temperatures of weaving and spinning rooms are carefully attended to,—for the reason that the perfect operation of the machine is more-or-less dependent upon a temperature sufficiently high to make the material work well,—ventilation is very little cared for. The smell of oil and the peculiar odor of wool disguises the "school-house smell" —as writers have been pleased to style the odor of ill-ventilated schoolrooms,—but it is there, all the same, and its causes are the same—exhalations from the persons of the operatives.

I recently examined on the boards of an architect some plans for a costly stable to be erected for the owner of valuable horses. A considerable item of expense called for in these plans was a system of ventilation for the stalls. I asked the architect whether this was demanded by the owner, or whether it was put in on his own initiative. "Why bless your heart!" was the reply, "the owner of those horses has brains. He knows that the health of horses must be perfect to have them show their best and do their best, just as much as though they were human, and a horse can not be kept in perfect health in foul air any more than a man can. 'A well-ventilated stable' were almost his first words in requesting me to draw the plans."

Surely this is a lesson on the value of ventilation to employers who want to get the best results for their wage expenditure. The total lack of pertinent statistics makes it impossible for me to enforce this lesson with an array of figures such as would prove the proposition.

It appears very strange to me that the subject of factory ventilation has received so little attention, while the collateral subject of factory heating has been carefully studied. Most of the ventilating appliances, where the nature of the operations carried out are such as to compel some sort of ventilation, are miserably inadequate, and it is only in recent years that forced mechanical ventilation has been adopted even in manufactures where deleterious or even poisonous gases or dust are evolved from the materials operated upon.

The overhead system of heating by steam-pipes ranged and suspended near the ceiling, where revolving shafts, pulleys and belting keep the air in motion, is a convenient way of heating a workroom and relieving the floor space from heating apparatus; but such ranges of heating pipes accumulate dust, and their position is unfavorable to a good system of ventilation. The extent to which overhead heating has been adopted in itself indicates the small importance in which factory ventilation has been held hitherto. Now, when it is remembered that rooms in most factories usually occupy entire floors—say 50 feet wide and from 100 to 300 feet long, while their height is not more than from 16 to 20 feet—it will be seen that a very different set of conditions exist in factory ventilation from those presented in a church, school, or theater. To attempt the removal of impure air from an outlet at one or both ends, or from the ends and the middle, of the room would entail the suction of all the bad air toward these points of egress, so that while in some parts the air might be unobjectionable, in the parts near the outlets impure air would be massed. The only correct way of ventilating such a room, in my opinion, is by numerous outlets uniformly arranged around the walls, and equally numerous inlets for pure air, and the securing of constant and uniform circulation by mechanical means. In designing a new building this would add very little, if anything, to the cost of erection. With engines of the non-condensing type supplying motive power, the exhaust steam can be used for heating and generally this supply would be ample. The current cost for ventilation would, in such a case, become the interest and deterioration on the cost of installation and the cost of the power necessary to run the blower.

Though, as above intimated, figures are not at hand to indicate the improvement either in output or quality of work in well-ventilated work-rooms, as compared with rooms or factories ill-ventilated, or not at all ventilated, I shall fail in the main purpose of this article if I cannot make a successful appeal to common sense to sustain my view of the case. Would not the cost of such ventilation as indicated in the

preceding paragraph be more than repaid in the increased pecuniary return realized in quality and quantity of work? This is the question which must be answered definitely and affirmatively before any general adoption of ventilation as a regular specialized feature of factory plants can be expected. The history of the world's industries affords no encouragement that working conditions will be spontaneously and vitally improved by the mass of employers, unless the latter can see profit in the change.

There is encouragement to be gathered in the effect upon special industries which have been derived from other improvements. It is within my memory and experience that, in a large manufacturing town, a new factory providing itself with nice washing facilities, toilet and wardrobe accommodations, and an elegantly kept lawn and flower garden under the advice of one of the broadest minded and most intelligent mill managers it has ever been my fortune to meet, did, by the liberal expenditure thus advised, become able to get the pick and cream of some ten thousand mill operatives in the town, with, as the superintendent personally assured me several years afterward, advantage that much more than justified the expenditure.

If there is profit in considering the personal cleanliness, convenience, and taste of factory workers, why, in the name of common sense, should there not be profit in considering their health? If ventilation is profitable for a horse-stable why should not a factory be systematically and thoroughly ventilated?

I have met with the following line of argument against the practicability of the proposition:

"In the effort to make factory ventilation popular with proprietors, there will be raised objections the same as, or analogous to, those made by railway managers to car ventilation. Good railway-car ventilation is conceded to be an impracticable scheme. The space to be ventilated is too small in proportion to the number of occupants to admit of a sufficiently rapid change of air without injurious and very annoying draughts. The heat that it is practicable to supply is inadequate to heating fresh cold air in quantity sufficient for good ventilation; and, worst of all, the people differ so in their desires for heat that you can not suit them all in this particular. Some sit in their wraps and overcoats while others remove them. The only way in which to compromise is to disregard the wants of passengers. Do the best you can conveniently, and let people continue to grumble. They will travel, all the same, ventilation or no ventilation. So the factory workers will be glad to get work, ventilation or no ventilation."

This argument, when thoroughly analyzed, is fallacious. If good ventilation would pay, the railways would supply it even if it required a single car for a single passenger. Passengers will not pay, as a rule, for good ventilation. A very large proportion of people occupy but a small proportion of their time in railway traveling, and prefer its temporary discomforts, and risk its injury to health, rather than pay the high fares which good ventilation and comfortable heating would demand. Passengers are not paid for services rendered to railway companies while riding in cars. If they were, the companies would strive to get the most for their money, by getting fullest service.

In hospital wards all in the same ward are served alike in the matter of heat and ventilation. If any wished to wear wraps or overcoats, and then complain of too much heat, they would be required to remove their coverings. Hospital administration is accompanied by discipline. So is factory administration. Railway companies cannot exclude cranks. In this respect a factory has the advantage over even a hospital. As to the difficulties of ventilation in factories, none exist that do not exist in hospitals, and, except in very rare instances where deleterious materials are handled and contaminate the air, one-fourth —or even less—of the amount of fresh air for good hospital ventilation would more than suffice.

The main question is, *"will it pay?"*

I am not alone in believing that it would. Good service—the best of its kind in any sort of mental or manual work—is compatible only with entire relief from other demands upon the vital forces. I do not believe a first-rate editorial can be written by a man whose head aches, or that a painter could paint an immortal picture standing at his easel with rheumatic pain in his knees. But even these uncomfortable pains would be less potent in obstructing high attainments than the languor, lassitude, and want of interest begotten by long confinement in the foul air of an oppressively heated and ill-ventilated room.

We are at the beginning of the twentieth century and the most conspicuous tendency of human activity is to get a maximum result by a minimum of expenditure. Minimum cost of fuel, of transportation, of brain and muscle, must hereafter be considered in the mighty competition that characterizes the commerce of the world. Maximum results include both quality and quantity. To get both of these the conditions must be, even to the smallest, compatible with most successful achievement. Ventilation in factories is one of these necessary conditions. It will repay its cost as well as any other investment in the fitting up of a well-designed factory.

FUEL COMBUSTION WITH DRAFT FURNISHED BY MECHANICAL METHODS.

By William Wallace Christie.

Mr. Christie's first paper, dealing chiefly with the intelligent study of the boiler furnace, appeared in THE ENGINEERING MAGAZINE for March, 1901.

MY preceding article dealt with the essentials of a commercially perfect boiler setting and the conditions to be maintained in operating the boiler plant, leading up to the requirements of economy in the matter of temperature of the flue gases. It was assumed that when the escaping gases from the boiler furnace entered the flue to the chimney their temperature should be 500° F., which in itself represents a waste of heat.

But there has not been great waste in the boiler, and this temperature given for the flue gases cannot be lowered much in the boiler without detriment to the quality of the steam made. The temperature of steam at 60 pounds' pressure is about 307° F., at 100 pounds it is 338° F., and at 150 pounds 366° F.—only 193° F. to 134° F. lower than the flue temperature; hence we must look outside of the boiler itself for prevention of waste after gases enter the flue. We may add to the plant an economizer, practically a feed-water heater, in which the tubes containing the water to be heated are of cast iron, surrounded by the hot escaping gases, the tubes themselves being kept clear of ashes and soot by scrapers operated vertically by a small engine. The economizer, being virtually a section of the flue, is so located that the gases may either pass through it direct or by-pass to the chimney or blower.

From four tests made by Mr. G. H. Barrus, we have results showing that the evaporative efficiency of the boiler may be increased from 7 to 12.8 per cent. by the use of an economizer, as follows:

	1	2	3	4
Temp. of gases lost in economizer, degrees F.....	145	107	104	156
Temp. of feed water raised in economizer, degrees F...	80	66	58	92
Temp. of gases leaving economizer, degrees F.....	231	254	299	279
Percentage of increase in evaporation due to economizer	10½	7	9.3	12.8

The temperature of the gases leaving the economizer, it will be noticed, varies from 231° F. to 299° F. If the gases passed immediately to a chimney the intensity of draft would be in proportion to the ab-

solute temperatures, or for the 500° F. case 961° F., for the 231° F., 692° F., and for the 299° F., 760° F. In a general way the intensity of the draft is diminished by the economizer by about 30 per cent. of what it would have been had the gases gone direct to the chimney; so that to produce the same draft in the economizer plant we should need a chimney say 41 per cent. taller than with the economizer omitted.

On account of this loss of heat, mechanical means are frequently used when economizers are installed, to bring the draft up to what it should be, without increasing the height of the chimney. Sometimes the chimney is cut out entirely, as would be done by some in designing a new plant. The Cheney Bros., South Manchester, Conn., having a chimney 90 feet high, wished more draft than it would produce; they installed a forced-draft outfit, to be used in connection with it, and an economizer. The gases enter the economizer at 475° F., and leave it at 275° F.

Unless the boilers and economizers are designed with special reference to forced combustion, the gases escape from the boiler at a much higher temperature than with natural draft, and we have a loss of efficiency in the boiler which must be made up in the economizer; even then the gases leaving the economizer in a forced-draft plant are not so very much lower in temperature than may be obtained with natural draft.

To burn fuel with forced draft is said to require about 50 per cent. of air additional to the theoretical quantity, or a total of 18 pounds per pound of coal. When natural draft is used, 100 per cent. additional air, or a total of 24 pounds per pound of coal, is requisite.*

Now with an outer-air temperature of 60° F.: With natural draft, 1 pound of coal requires 24 pounds air and gives off escaping gases at a temperature 440° F. above temperature. With forced draft, one pound of coal requires 18 pounds air and gives off escaping gases at a temperature 240° F. above atmosphere. To raise 1 pound of air 440° F. requires $0.2377 + 440 = 105$ B. T. U. To raise 1 pound of air 240° F. requires $0.2377 \times 240 = 57$ B. T. U. One pound of fuel with forced draft wastes 57 B. T. U. for each of its 18 pounds of air, a total loss of 1,126 B. T. U. One pound of fuel with natural draft wastes 105 B. T. U. for each of its 24 pounds of air, a total loss of 2,520 B. T. U. So that the actual waste from using natural draft is 1,394 B. T. U. per pound of coal burned. As the heat units in one pound of coal may be taken at 14,200 B. T. U., the heat loss with

* There is much uncertainty as to just how much air is used at any time, so these figures must be taken with considerable allowance, both quantitatively and comparatively.

chimney draft is greater than that with blower (no operating expenses being considered) by 1,394 B. T. U. or $\frac{1394 \times 100}{14,200} = 9.81$ per cent.; but it can be readily appreciated that as the air required to complete combustion, or admitted to the fire, when natural draft is used approaches in quantity that sent through by the blower, there is less and less economy of the former practice over the latter until when the quantities of air become equal there is no difference between the two methods except the additional operating expenses of the blower.

There are several mechanical methods of producing draft dynamic in their character, that is, having work expended on or through them; these are:

1. Forced draft.
2. Induced draft.
3. A combination of the above.
4. Forced-natural draft.
5. Steam jet in the chimney or flue.
6. Steam blower under the grate.

In connection with all of these a chimney or suitable outlet must be and is used.

1. Forced draft is simply draft produced by a blower forcing the air through pipes to the ash pit, and up through the coal and so out of the chimney. The advantages of forced draft compared with natural chimney draft are well summarized, in part, by Mr. Jas. Howden of England as follows:

a. Complete combustion of fuel of all qualities under conditions under which combustion could not be efficiently obtained by natural draft.

b. The power of regulating with ease the amount of combustion desired, from zero to many times that possible by natural draft, also the capability of maintaining the fuel in the furnace incandescent for a considerable time without appreciable consumption.

c. A great reduction in the size or number of boilers required to produce a given power, and the capability of increasing the power in steamships far beyond that now obtainable with natural draft.

d. Greater economy in producing steam, under which he names seven causes which I will not give here.

e. Less discomfort in stoking, etc. (marine work).

f. The complete absence of smoke.

2. Induced draft—the production of a partial vacuum at the furnace by the use of a blower located between the boiler furnace and the chimney, sucking the gases from the furnace and discharging them

from its own outlet generally through a chimney, which method is the most chimney-like of draft production.

3. Forced-induced draft is produced by a combination of the two methods mentioned above.

4. Forced-natural draft is secured by the use of a blower to supply the air necessary for combustion to a closed ash-pit, with proper regulation to maintain the desired steam pressure or quantity of air for combustion, while a chimney is used to draw the gases away from the boiler. This system, as well as the others, has produced very desirable results under certain conditions. From tests by Barrus, where forced-natural draft was used we have the following very economical results:

Boiler pressure, lbs. per sq. in.....	63	68	70	71
Temp. of escaping gases, F.....	346	355	395	400

5. Steam jets and steam blowers as a rule are not employed unless a chimney is in use; while producing draft and aiding combustion to a certain degree, they make a very uneconomical combination.

All of the blower methods of draft production must be considered in connection with, and planned with special regard to, the quantity of fuel to be burned in a given time and the amount of air needed for the complete combustion of the fuel, which air must necessarily pass through the blowers. Pure carbon requires 11.5 pounds of air per pound of carbon for complete or perfect combustion. Coal, both anthracite or bituminous, requires about 12 pounds of air per pound of fuel per hour. With forced draft in operation a dilution of 50 per cent. is advisable, 18 pounds of air being provided per pound of fuel; with chimney draft, 100 per cent. excess, or a total of 24 pounds of air per pound of fuel is needed. One English authority says approximately 20 pounds of air are required per pound of fuel for complete combustion. So that for 100 boiler horse power, made by burning 400 pounds of coal per hour, we should need an air supply of $400 \times 24 = 9{,}600$ pounds of air per hour, or $9{,}600 \times 12\frac{1}{2} = 120{,}000$ cubic feet of air per hour to be passed through the furance at a velocity of 45,000 feet per hour; we would, therefore, require a blast-pipe area of $\frac{120{,}000}{45{,}000} = 2.66$ square feet, or 383.04 square inches, which would also be the capacity area of the fan. The proportions may be determined from the approximate formula capacity-area $= \frac{D\,W}{3}$, D being the diameter of the fan wheel in inches, W the width of fan wheel at circumference in inches. We should then have in this case $383 = \frac{D\,W}{3}$, or $1{,}145 = D\,W$. For a 6-foot or 72-inch wheeel, W would equal $\frac{1145}{72}$ or 16 inches width of fan wheel at circumference; for an 84-inch wheel W would work out to a 13-inch width. The nozzle area should be

somewhat larger than 383 square inches, say 22 or 23 inches diameter. The volume of air passing through the fan should be calculated from the capacity area. R. C. Carpenter gives this rule* for centrifugal fans: The number of cubic feet of air discharged in one revolution of the fan is equal to the cube of the diameter of the fan expressed in feet, multiplied by constant 0.5 if there was a free delivery, and 0.4 if the pressure was about that found in ordinary practice, or equal to the pressure of 1½ inches of water, and he shows by the results of an actual test,† "that for that plant, at least, a gain of a good many horse power would have been possible by the substitution of mechanical for natural draft, provided the heat discharged from the flue could have been saved and utilized."

If this heat loss can be taken by an economiser, which I have already referred to, or by a flue heater, we have in addition to its operating expenses that of the blower; for all installations having blowers require power to operate them. This power is obtained either by belt from a main line shaft or from an electrical motor, or, what is usually considered far preferable, by a steam engine or electric motor directly connected to it, or at least on the same frame.

The steam or power used to operate blowers is from 1 to 7 per cent. of the steam made under the boilers; as low a figure as 0.5 of one per cent. has been given. When the economizer is used we should add the expense of maintaining and operating it to the blower expense.

According to Péclet, chimney draft produced by the heat of the gases involves an expense exceeding one-fourth of the combustible used. If the heat in these gases can be utilized, as in the economizer, etc., the more economical mechanical draft may be used, but when no means of utilising the heat is available, it is advisable to employ it to produce the draft in a chimney.

Mr. W. R. Roney‡ says, referring to the designs for a mechanical-draft and economizer plant for 6,000 boiler horse power, with duplicate fans, that the power required to drive one fan was 6-10 of one per cent. of the boiler horse power developed * * * (coal costing $3 per ton) * * * "it would not pay to build the chimney so long as money was worth more than 2 per cent. per annum." If the boiler plant was used at half or double capacity, the fan draft would probably cost all that interest on the chimney would amount to, for money can be had at 4 or 5 per cent. with ease.

* Eng. Record, p. 354, Vol. 38.

† Machinery, June, 1895.

‡ Trans. Am. Soc. Mech. Eng., Vol. XV.

The efficiency of a fan blower falls off very rapidly when used either above or below the capacity for which it is designed, so that it becomes more than ever an expense when worked under either of these conditions. Theoretically, if the centrifugal-fan speed is doubled, the volume is doubled, the pressure is increased four times, and the horse power eight times.

Mechanical draft may be said to cover a multitude of sins in the original design and installation of steam plants and of their flues and chimneys, and further sins in their use far beyond the original calculation.

Theoretically, under certain conditions using natural draught instead of forced draft with an economizer wastes 9.81 per cent., not counting the cost of operation or fixed charges. But this can scarcely be charged against the chimney, as we have no means of utilizing this heat; in the latter case the economizer has given all the heat possible to the water feeding the boilers.

The nearer the quantity of air supplied to a furnace is to the theoretical quantity required, and the lower the steam pressure carried in the boilers, the cheaper natural chimney draft becomes.*

Chimneys present certain fixed, unalterable conditions of location and erection, which limit their adaptability to changes in requirements. Blowers are out of the way; so is a steel chimney over a boiler. Blowers prevent smoke; so does a proper boiler setting with the air supply regulated in the proper way. Blowers can be regulated; one would think that "damper regulators" had never been heard of in connection with chimneys—in fact many plants are not equipped with them now.

As forced draft used alone gives a higher temperature of the escaping gases than that produced by natural chimney draft, the saving due to a combination of it with the economizer should be credited to the latter alone.

A forced-draft plant at present in operation, without an economizer, heats the steel chimney where it goes through the roof of the boiler house to a dull red heat, or about 1,000° F.; at the Otto Colliery, Branchdale, Pa., cylinder boilers, forced draft, have gases escaping at a temperature of 1,600° F., and vertical boilers, 711-732° F., the evap-

* The effect of the quantity of surplus air on the temperature of combustion in the furnace is for theoretical quantity of air..... 4640 degrees F. above 32 degrees F.
50 per cent. additional air..... 3332 degrees F. above 32 degrees F.
100 per cent. additional air..... 2505 degrees F. above 32 degrees F.
When the gases are under pressure as in stokeholds of vessels, the temperature of combustion is at ordinary atmospheric pressure..... 2760 degrees F. above 32 degrees F.
At pressure of 2 atmospheres..... 3475 degrees F. above 32 degrees F.
At pressure of 3 atmospheres..... 3968 degrees F. above 32 degrees F.

orative efficiency being low, but higher comparatively (as a poor fuel is used) than originally with natural draft.

High temperature conditions do not continue after a certain rate of combustion is reached, as shown by the Purdue locomotive tests, with varying grate area and rate of combustion and the same total pounds of coal burned in the same time for each test.

Coal per hour per square feet of grate.....	61.40	83.50	124.20	240.80
Smoke box temperature, F.....	647	629	610	500
Draft in inches of water.....	2.20	2.50	3.30	5.60

With a chimney alone producing draft we have a heat loss somewhat less than with a blower alone producing draft; to this is to be added the cost of operation of the blower, or from 1 to 7 per cent. With a blower and economizer, giving the same flue temperature as in a chimney and economizer, there is a loss of the cost of operating the blower.

One of the inducements offered to steam users, as in favor of forced combustion, is the saving made possible through the ability to burn cheaper fuel; but this would also be possible in a plant having a chimney designed for the furnace. We are necessarily governed somewhat in our selection of the method to be used in producing draft by the fuel at hand to be burned, but the draft required for efficient combustion even of poor fuels, in the majority of cases, is not outside the limit of that which a chimney of moderate height will produce.

Steam blowers under grates are used in connection with some mechanical stokers, and under boilers whose chimneys have been built too small, or have become so by the inevitable result of expansion in the boiler plant. Steam jets are used in chimney flues for the same reason.

In the emergencies which come to naval vessels, and occasionally to certain steam plants, an undersized chimney will be materially aided by a blower outfit. Then again about 25 pounds of coal per square foot of grate is all that can be burned, advisedly, with natural draft; beyond that forced combustion is necessary. But given a boiler plant with its every detail planned for the work to be done and fuel to be burned, I do not believe that mechanical draft will be anything but an expense over natural chimney draft, and a considerable expense at that.

The life of a fan is probably 15 years or under, when it is ready for the scrap heap. The life of a steel unlined chimney (the cheapest kind) is about the same, while a brick chimney, well-built, should not need expensive repairs before the end of fifty years and should last one hundred years. The cost* of any forced-combustion apparatus or of

* W. W. Christie, in the *Railroad Gazette*, Vol. 32, page 688. See also "Chimney Design and Theory—by the same author.

chimneys depends wholly upon the kind of installation. Good brick chimneys, double-shell, cost from $3.00 to $7.00 a rated boiler horse power; other styles a less amount. Another writer gives the cost of brick chimneys as nearly proportional to the cube root of the area in square feet, multiplied by the cube of the square root of the height in feet.

The fixed charges can be stated more closely and I would consider them to be 12 per cent. for mechanical draft and 8 per cent. for a good double-shell brick chimney; 11½ per cent. for a steel shell, unlined. For small horse power, I believe the guyed steel chimney can be installed for less money than the blower outfit. For large powers, the mechanical apparatus is the cheapest in cost price.

In 1894, W. R. Roney,* in concluding a paper on mechanical draft, says: "I venture the prophecy that the time is not far distant when tall-chimney building will be one of the lost arts, and the progressive engineer will point, as his monument, not to the tall and expensive chimney of the past, but to the comparatively inexpensive and economical draft of the future."

Now in 1901, seven years later we have or find just completed or building these large chimneys:

LOCATION.	HEIGHT.	DIAMETER.	MATERIAL.
Bethlehem Steel Co., Bethlehem, Pa. (1).	175	9	Radial brick.
Bethlehem Steel Co., Bethlehem, Pa. (2).	175	8	Radial brick.
Yorkville Hygeia Ice Co., N. Y.	190	7½	Radial brick.
N. Y. Shipbuilding Co., Camden, N. J.	200	8½	Radial brick.
Great Northern Paper Co., Millinocket, Me.	235	12	Radial brick.
Boston Elevated R. R. Co., Lincoln Wharf, Mass.	251½	13	Common red brick.
Manhattan Railway Co., N. Y.	278	17	Common and radial brick.
Metropolitan Traction Co., N. Y.	353	22	Common red brick.
Orford Copper Co., Constables Hook, N. J.	360	13	Radial brick.

In radial-brick chimneys the diameter of flue is measured at the smallest section; in common-brick chimneys the diameter is uniform.

These instances cover some of the largest American steam installations of immediately recent construction, and being designed and advised by the highest class of engineers obtainable, the fact that the plants have chimneys alone in the majority of cases, while in none of them are blowers used alone, speaks volumes for the chimney still continuing with us for a time, even though it may as in some of the above cases have the company of a blower.

* Trans. Am. Soc. Mech. Engrs., Vol. XV.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

By A. G. Charleton.

III.—WATER PROBLEMS AND THEIR SOLUTION.

Mr. Charleton's series, which began in the February issue of the Magazine, has so far included reviews of the general topography and conditions of the West Australian fields, the chief geological features, and the peculiar process of "dry-blowing" for gold. The present article is devoted to the most characteristic and important problem of the region. It will be followed by a fully illustrated review of mining and milling practice as developed in Westralia.—THE EDITORS.

EARLY in the history of the West Australian fields the question of obtaining an adequate supply of water for mining purposes presented no little difficulty, but various expedients soon suggested themselves by which to overcome the apparent want of this element essential to the development of the industry on a fairly extensive scale.

The ordinary and natural means of obtaining the requisite supply were:

1. By conserving the rain water in dams.

2. By drawing it from natural reservoirs, such as the salt lakes and creek beds, as in the northern part of the colony more particularly (owing to the comparatively heavy rain-fall) fairly large quantities of water are stored in their sandy bottoms.

3. By pumping up the "ground-water," drawn from shafts, bores, etc., which is usually found at the ordinary drainage level of the country, *viz.*, at the horizon where surface oxidation ceases and the relatively harder underlying rocks offer a certain barrier to the further descent of the water, which has penetrated the overlying ground. Below this line, the water generally decreases, and the mine workings are in consequence frequently almost dry.

Conservation in Dams.—A rain-fall of 4 to 8 inches per annum, such as obtains around Coolgardie and Kalgoorlie, will yield a very large water-supply provided any considerable portion of it can be retained, a fall of one inch of rain representing no less than 22,651 gallons per acre, or 14,500,000 gallons per square mile.

The nature of the surface in the catchment area of the dam is,

however, a matter of great importance, a heavy shower being necessary to make a surface flow, except on rock areas. But where, as in many parts of the colony, large bare bosses of granite are met with, running from 10 up to 200 acres in extent, they offer a splendid catchment for even the lightest showers. The rain thus collected (as may be seen at the Government dams on the road from Southern Cross to Coolgardie) is caught by cutting a drain around the toe of the rock and leading the water thence to a tank excavated on the lower side.

Some of the valleys, which would otherwise form good catchment areas are rendered useless by the pervious character of their surface soil, as all but very heavy rain is at once absorbed in the ground and does not find its way to the tank. There are, however, certain valleys (generally flanked by low ridges strewn with black-ironstone pebbles), the surface of which is covered with a thin coating of clay, which is impervious to even a straight fall of rain and prevents the absorption of the water by the dry earth beneath. These "clay-pans," formed in natural depressions in various localities, have yielded a large portion of the water-supply that outside prospectors have had to depend upon, and answer the purpose excellently so long as the surface of the ground in the catchment area remains undisturbed. As showing the importance of this latter condition, Mr. J. W. Archibald states* that about a mile southeast of Coolgardie there are two Government tanks of about half-a-million gallons capacity each, and every shower of rain adds to their supply, whilst in two other tanks in the neighbourhood, where the surface of the basin has been disturbed by dry-blowers, only heavy rains will cause any water to flow into the dams at all.

The configuration of the country being generally flat, there are but few sites available where water can be impounded in any large quantity by means of "weirs," and therefore, as a rule, tanks for storage have to be excavated. Mr. Archibald remarks that the sites for these excavations have to be carefully selected and proved by test-holes, as in some cases the greenstone bottom contains small pipes or bores ½ inch to 1 inch in diameter, filled with soluble salts; in cases where their existence has been overlooked, on the inflow of water into the dam an active ebullition has taken place, the soluble minerals being dissolved out of the bore-holes, which then present the appearance of small round holes, with a clean hard casing, and convey the water away to where it is lost in the rocks. Mr. Archibald states that a dam of 500,000 gallons capacity near Coolgardie, filled by a storm in the early part of 1895, was completely drained within 16 hours, and the

* *The Financial Times*, May 1st, 1896.

bottom of the tank showed 83 such holes. This difficulty has been overcome by puddling the bottom and sides of the tanks; in many cases, however, the alluvium in the valley is deep enough to afford tight ground.

The chief objections to this method of conservation are the delay in making a tank and the uncertainty in regard to the time which may elapse before a storm will fill it, and this means of storage met at first with some discouragement owing to the failure of many tanks to hold water, before the nature of the ground was understood and the proper remedies were applied. The Government has wisely, however, voted and laid out very large sums of money for works of this kind.

Natural Reservoirs.—The chain of salt lakes, which run in a north-by-east direction from the head of the waters that flow into the Great Australian Bight on the south through Lakes Cowan, Lefroy, I. O. U., Carey, and Darlot northward, are flanked as a general rule by diorite ridges, intersected by well defined east and west valleys, which through long periods of time have emptied their storm waters into these depressions. They probably owe their origin to a general subsidence of the country, somewhat parallel with the ranges, which were elevated during a period of volcanic activity that doubtless occasioned an extensive series of "faults" along this line of country; and the deep beds of alluvium (the product of the disintegration of the underlying rocks), collected in the lake-bottoms (known as "soaks"), which have levelled up large areas, are now the storing-places of large accumulations of water which they protect from too rapid evaporation. In other places, the rock-bottom lies evenly within a few inches of the surface of the lake, and the loss from evaporation is very great.

Mr. Archibald observes: "Occasionally during the winter months or in time of heavy storms, the surface of these lakes is covered with sheets of water. The surface waters, draining into these lakes for long periods of time, have in their course picked up quantities of soluble minerals derived from the decomposition of the volcanic rocks. The evaporation, which is excessive on such large shallow areas, has caused the precipitation and consequent concentration of the salts in these lakes to such an extent that the water met with in their alluvium is almost saturated, carrying, as a rule, 20 per cent. to 28 per cent. of solid matter. The minerals taken into solution are mostly soluble salts of sodium, lime, and magnesia. Of these the sulphate of lime, being less soluble, was first precipitated out of the saturated fluid on the surface of the lake, the more soluble sodium chlorides being carried deeper into the silt-beds. The crystals, mostly of gypsum, being ex-

posed on the surface of the lake, have by the action of the wind been accumulated in the sand ridges occurring in the low passes between the lakes. In localities where the rock bottom of the lake is comparatively deep, very large quantities of salt-water are stored in the silt-deposits, and they are in places being utilised for milling purposes by opening long trenches through the lakes. The water soaks into these trenches, and is thence conducted to a central pumping station, and although supplies of this nature are dependent on the character of the salt lakes from which they are drawn, under the most favourable conditions large quantities of brackish water may be drawn from such sources. The neighbourhood of these lakes appears also to offer good natural sites for catchment areas of great extent, which hereafter may be utilised for the construction of large impounding-dams for public water-supply purposes."

Ground-water, Wells, Bores, etc.—At different depths down to 200 or 300 feet supplies of water are met with, varying in quantity and quality with the surrounding local conditions. Such water is due to absorption into the rocks of the rainfall during long periods, in places where the surface consists of loose soil (as in the "sand-plains") or where the out-cropping rocks are pervious, and a slow accumulation takes place through the fissures and joints. Consequently, by a careful examination of the surface features and character of the rocks, the points where such wells can be advantageously located may be decided with reasonable certainty.

In the granite rock and gneiss-granites near Coolgardie, Mr. Archibald states there are many such wells, with a daily output ranging from 1,000 to 6,000 gallons per day, situated in most cases near the contact of the granite and greenstones. The water is found in shafts at a depth ranging from 170 to 180 feet, being in some cases fresh, in others carrying as much as 2 per cent. of solid matter. As a rule these rocks have yielded, by their disintegration, the loose sandy soil known as "sand-plains," and the water has percolated through the soil into the more pervious part of the rock until tight ground is met with below, when by putting in drives across the general run of the fissures that carry the water it can be conveyed to a main water-shaft. Mr. Archibald ascribes the comparative freshness of the water in some cases to the fact that the felspars of the granite rocks are more insoluble than those of the greenstones. In the diorite and schists, variable supplies from the same source are met with, but the water generally carries a higher percentage of soluble salts.

In places where soft dykes, reefs, etc., intersect these rocks, or

DRY BLOWING AT COOLGARDIE. THE PROCESS MADE NECESSARY BY SCARCITY OF WATER.

By courtesy of T. A. Rickard, Esq.

where the soft decomposed diorite slates extend downwards to a considerable depth, supplies of water are often struck, however, which are of considerable extent when considered in regard to the small amount of work done in developing them. Thus in the vicinity of Coolgardie, such mines as Cosgroves and Bayley's Consols are stated to produce, from limited developments, 10,000 to 20,000 gallons, and the Hit or Miss Mine, near Kanowna, is said to yield 18,000 gallons daily from

above the 120-foot level. Many shafts which are much below levels where water is usually obtained are, however, dry.

When, as frequently is the case, a stratum of harder and impervious rock is met with, underlying the softer rocks where water is found, a well sunk into the impervious rock with drives running out across the strike of the country at this level affords the best means of developing a water-supply of this kind to its fullest capacity, and in some such wells at any rate the production appears fairly constant. Thus the Government well at Coolgardie, Mr. Archibald states, yielded for a couple of years 6,000 gallons per day, and the flow of water did not seem to increase at the time of rain-falls, indicating that the percolation into the shaft, although slow, extends for some distance.

The sinking of other wells in the gneiss-granite within a chain or two of one another does not appear to have affected the supply, and the same may be said of the water-shafts at some of the mines. In certain cases, however, where the rock is more permeable, a diminution of flow takes place when the reservoir is heavily drained, the water gravitating towards the deepest shaft; the only remedy is to enlarge the area of drainage by sinking new shafts.

Bores.—On the Hampton Plains, on Block 49, a diamond-drill bore, located in one of the long east-and-west valleys before referred to, passed through deep beds of alluvium, sand, cement, and decomposed rock, to a depth of 150 feet, and at 170 feet met with hard rock, where a supply of water was struck stated to amount to more than 40,000 gallons per diem. Other bore-holes have been put down with success, near Coolgardie and elsewhere.

General Character of the Water-Supply.—Considering what has been said, it is scarcely surprising that the water of the country generally is excessively salt, almost in fact to the point of saturation, and had it not been for the energetic action of the Government supplemented by private enterprise in establishing "condensing-plants" along the main-roads, to convert the brine of the wells into potable water for man and beast, travel from place to place would have been greatly restricted and conditions of existence in some of the older mining-camps would have been rendered intolerable, postponing the development in all probability indefinitely.

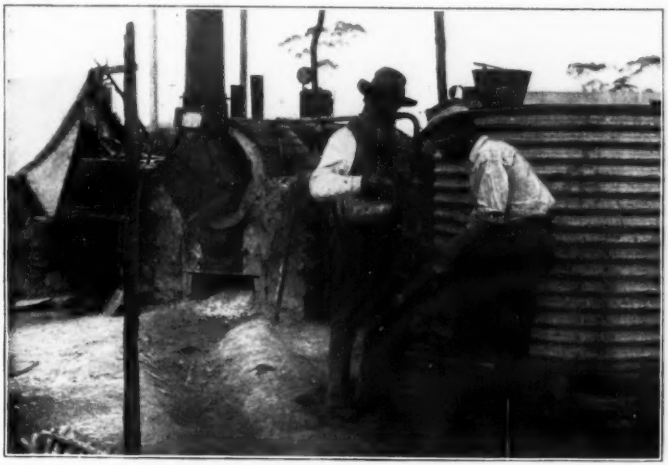
Comparing it with ordinary sea-water, which contains some 3½ per cent. of salts (three-quarters of which is sodium chloride), Mr. T. A. Rickard,* to illustrate the excessive salinity of the water in Western Australia, states that at the Queensland Menzies mine he

* The Alluvial Deposits of Western Australia. Trans. Am. Inst. of Ming. Engrs.

found them using water in September, 1897, which contained 17 per cent. of salts; and he was informed by the manager that evaporation in the hot weather in December increased the amount to 30 per cent. For this liquid, which came from a neighbouring "soak," 25*s.* was paid* per 1,000 gallons, and the item of water alone for milling, in a ten-stamp mill, amounted to 13*s.* per ton; whilst the condensed water bought for use in the boilers cost 20 shillings per 100 gallons.

The chief salts present in a sample of water from the Great Boulder Proprietary, Mr. Rickard considers, were:

	Grammes per Litre.
Calcium Carbonate ($CaCO_3$)	0.145
Calcium Sulphate ($CaSO$)	4.365
Magnesium Sulphate ($MgSO_4$)	5.189
Magnesium Chloride ($MgCl_2$)	15.144
Sodium Chloride ($NaCl$)	21.467



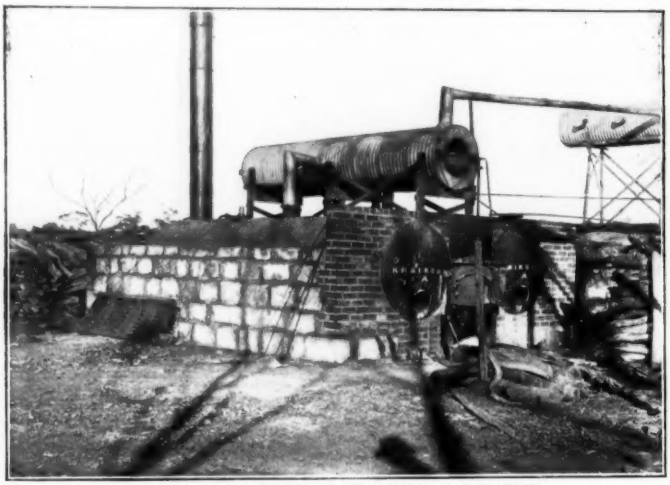
BUYING WATER AT A CONDENSER IN WEST AUSTRALIA
By courtesy of T. A. Rickard, Esq.

To render water of this description fit for consumption or use in steam boilers it must needs be distilled, and the apparatus used for this purpose, termed a "condenser" in Western Australia, is a prominent feature of every district where a settlement exists or mining is carried on. It might more properly be called a "still," but Mr. Rickard traces

* 10*s.* per 1,000 was, I am informed, paid for salt water in Kalgoorlie in November, 1897, and Mr. Hoover states that as much as 30*s.* per 1,000 has been paid in Western Australia for salt water.—*Eng. & Ming. Journal*, Dec. 17, 1898.

the use of the term "condenser" to the sailors who took part in the early exploring expeditions. Any suitable type of boiler can be used for converting the salt water into steam, which is then condensed in vessels presenting a maximum of cooling-surface. In the older condenser plants the general type of boiler used consisted of ships' tanks having a capacity of 400 gallons, which were usually set on edge in pairs. The steam is drawn off from the tanks through short vertical iron pipes, which pass into the condensing chambers or "coolers." The average product of each such tank is about 300 gallons of distilled water daily.

Mr. Rickard states that a first-class condenser plant of this description would require at least eight boilers, giving a daily yield of 2,400 gallons; but the capacity of the plant at some of the mines now runs up, according to Mr. G. J. Bancroft, to 5,000 gallons per diem.



CONDENSER AT THE IRON KING MINE, KALGOORLIE.
By courtesy of T. A. Rickard, Esq.

The coolers at first employed to condense the steam were plain circular towers, about 30 feet in height and 3 feet in diameter, built of sheets of corrugated iron, rivetted and soldered together, and closed at the top and bottom with flat sheets of galvanised iron, several such towers being connected by a 6-inch pipe so that the steam travelled up one and down the next. Annular coolers were next substituted, consisting of an outer cylinder of corrugated iron, 2.5 feet in diameter, surrounding an inner 1.5-feet cylinder, so as to leave a circular space 6 inches wide between them, containing the steam; the inner tube being

open at both ends, by tilting the cooler at a slight angle a current of air is made to pass through the centre of the surrounding steam-jacket. A plant of this kind, which cost about £100, was erected some years back at the Lake View and Boulder Junction Mine, and possessed a capacity of 1,500 gallons of condensed water a day. The water which comes from this mine has a specific gravity of 1.03385, the total solids amounting, according to an analysis by Mr. E. S. Simpson, to 4.93 per cent., and the chlorine present to 2.39 per cent.

AN AUSTRALIAN ALLUVIAL CLAIM, SHOWING THE CONDENSER.

In plants which have been more recently built the boilers or "evaporators" are either of the cylindrical under-fired class, about 18 feet long, and 4 feet in diameter, like those in use at the Great Boulder, or of an egg-shaped section.

They are provided with necessary fittings and built in like a steam boiler, whilst the fronts are made removable, so as to permit quick and easy cleaning, which is a matter of great importance. Two evaporators of this type supply enough steam to produce 1,200 to 2,000 gallons of fresh water daily. The coolers have also been improved, consisting in some cases of a battery of long galvanised pipes of comparatively small diameter, 4 to 6 inches, cooled* by the surrounding

* There seems no reason why a nest of pipes of this sort should not be jacketted and water-cooled, using the cold salt-water coming from the mine, thus heating it on its way to the evaporator, by which benefit ought to be derived both ways and the cost of condensation be correspondingly reduced.

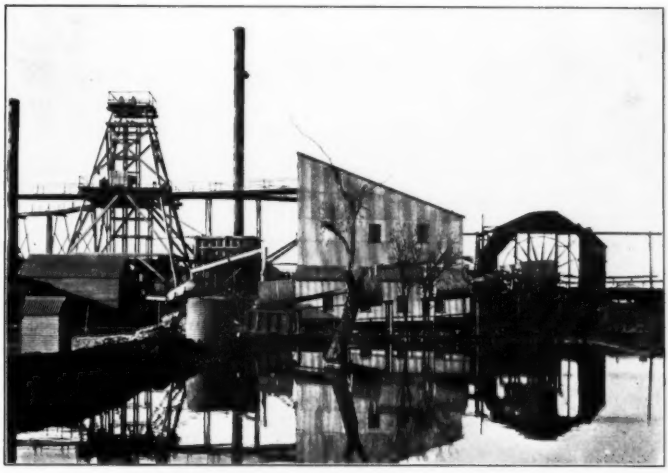
air, connected with steam chests at each end; but more commonly they are formed of galvanised-iron drums (like water tanks) closed at top and bottom, except where the pipe for the entry and exit of the steam joins them together, and contain about five 4-inch pipes, open at the ends, running through them longitudinally and allowing the air to pass through the tubes when the drum is tilted slightly out of the horizontal. This type is also frequently used in combination with vertical water-coolers, similar to the annular air-coolers previously described, but with one end of the interior space closed by a plate, so that when set upright the centre can be filled with water. Pipes are of course provided in the bottom of the coolers for drawing off the condensed water into tanks, where it is stored and cooled.

Mr. Rickard mentions* that early in 1898 salt water cost 2*s.* to 4*s.* per 1,000 gallons; these figures, however, evidently did not include delivery (which varies with the distance and quantity pumped), and for the period the paper relates to they appear even rather low, as in a paper written about the same time (the beginning of 1898), Mr. Wm. Frechville stated it was selling at 5*s.*, and this was, I believe, about the general price at the shaft's mouth in 1897, although the figure fell shortly afterwards and water could be purchased for 3*s.* 6*d.* at the mines; whilst at the present time (1900) it can be bought for 2*s.* 6*d.*

Without allowing anything for first cost of laying down pipes and pumps (everything else, however, included), salt water was still costing some of the largest of the Kalgoorlie mines 4*s.* 6*d.* per 1,000 gallons delivered, in 1899; and when, as in some cases, the water has to be pumped with a small engine and boiler half a mile or more, the wages paid and wood actually consumed may easily add to the price of the water at the shaft as much as 2*s.* per 1,000 for delivery. In a case of the kind which came under my notice, a 3 foot by 7 foot 6 vertical-type boiler burnt about ⅝ of a cord of hard-wood on two shifts, *i. e.*, 16 hours, supplying steam to a No. 4 Tangye pump, having 3-inch water and 4½-inch steam cylinders, with a 7-inch stroke, and requiring a man on each shift to look after the firing of the boilers. The water is measured by meter.

Mr. Hamilton informs me that 70,000 gallons of salt water per day are supplied to the Great Boulder from various sources, coming principally from shafts on the property and the adjoining leases; it contains from 4.84 to 11.02 per cent. of soluble salts, and exclusive of purchase of water, he reckons it costs a half penny per gallon to condense.

* Notes on a Visit to the Gold Mines at Kalgoorlie, W. A. Trans. Inst. Ming. Met.



GOLDEN HORSESHOE GOLD MINING COMPANY'S PLANT.

Showing storage pond for waste water, with part of the condenser plant.

At the Ivanhoe Mine, I am informed by Mr. Hewitson, the water supply is drawn from a low-lying alluvial flat west of the gold belt, where the company own 76 acres of leased water-rights, on which a shaft has been sunk to a depth of 135 feet and equipped for bailing and pumping water up to the mine, a distance of 6,000 feet, with a vertical lift of 90 feet from the surface of the water area up to that of the mining lease. This furnishes a supply of 40,000 to 50,000 gallons per day, containing about 7 per cent. of solid salts, and is not unlikely to be supplemented by bringing in water from the Hampton Plains Estate. Mr. Hewitson reckons the cost of condensing at £2.5*s.* per 1,000 gallons, but the price varies no doubt somewhat with the quality of the water and the season, as Mr. Rickard stated the average cost in 1898 was about 5*s.* per 1,000 gallons during the cool season and 6*s.* during the summer. The cost of condensing, it thus appears, has fallen from the figure of 1*d.* to 3*d.* per gallon, at which it used to be reckoned, and whilst in November, 1897, condensed water sold for 100 to 150*s.* per 1,000 gallons, or say 12*s.* per 100,* in 1899 the winter price was only about 7*s.* per 100, and 9*s.* in the summer, or an average of 8*s.*

As a basis for calculation, Mr. Hewitson states that on a production of 2,400 gallons of fresh water per day, the expenditure would include the labour of two men (one on each shift), 2½ cords of wood

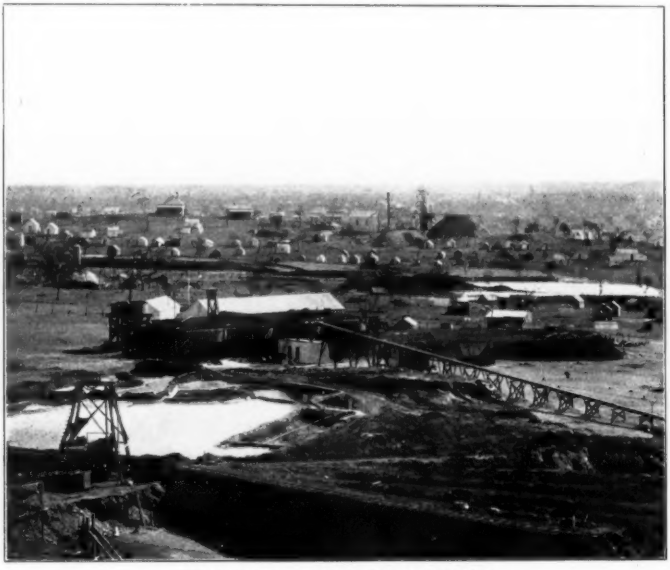
* It has fetched 14*s.* and more.

(1 cord of wood per 1,000 gallons of condensed water), and 3,200 gallons of salt water.

Water for drinking and household purposes is obtained partly from tanks which catch the rain-fall from the roofs, but it is apt to become contaminated with salts of zinc and impurities due to dust, dead frogs, etc.

The density of the salt water is no doubt an obstacle to amalgamation, in consequence of the fact that, the ore being particularly liable to "slime," the fine particles can less easily settle on the copper plates, and run the risk of being carried away in the tailings. To prevent the decomposition of the stock-solution in the cyanide works, the magnesia is precipitated with lime. The chloride of magnesium present in the mill-water, according to Mr. H. P. Woodward, tends, however, to sicken the mercury in the mills.

Estimates of the loss of water from various causes are exceedingly variable; thus whilst it is claimed that milling and cyaniding can be done with a loss of 0.25 tons of water to the ton of ore (using the water, of course, over and over again), Mr. Geo. Bancroft estimates that in most of the mills 0.5 ton of water is lost per ton of ore. Even



CYANIDE VATS, NORTH BOULDER MINES.
Showing conservation of waste water behind dams made of tailings.

this, however, appears considerably underestimated. Mr. H. C. Hoover,* putting the average mill, steam, and domestic loss at about 400 gallons of 10 lb. each per ton of ore milled. When the tailings and slimes are treated, however, he states that some portion of this can be saved, reducing the loss to about 250 gallons per ton of ore. At North Boulder, in October, 1898, the loss amounted to 367 gallons per ton, and in December to 496 gallons.

The ordinary loss is probably therefore actually as Mr. Wm. Frecheville says, between 200 and 400 gallons per ton, although I am informed by Mr. Skews that in the warm weather (owing to the evaporation in the dams) it sometimes rises to 1,000 gallons per ton. Cyaniding alone, according to Mr. Bancroft, entails a loss of 15 per cent. Mr. Callahan considered, I am told, that there was an average difference in consumption in summer and winter of some 300 gallons per ton. It would, however, be interesting and of value to have more complete data on these points, showing under what heads losses occur and what they amount to, under different conditions.

Mining companies generally allow their workmen, if single, 2 to 3 gallons of condensed water a day gratis, and married men 4 gallons, which is regularly served out to them, the water tanks being arranged so that the taps are padlocked, to prevent theft.

It will be clear from what has been already said that, dry as the country appears to be on the surface, there is an abundance of water for carrying on *ordinary small mining undertakings*, but, on the other hand, it is evident that a large and important camp like Kalgoorlie could never expand on a scale commensurate with its possibilities and the value at which mining properties in the district have been capitalised, if it had to depend alone on the sources of supply of which mention has been made, for the simple reason that *large quantities of low-grade ore* could never be worked at a profit.

As it is a well-recognised fact that the success of a mining camp largely depends on its ability to work low-grade ores cheaply, it being far more profitable to do so than to treat high-grade ores in small quantity (which is always an expensive matter), the question of how to solve the water-difficulty (which is perhaps quite as important as the "sulphide problem," if not more so), has long exercised the minds of everyone interested in the West Australian industry. Optimists, whose wishes were the parents of their thoughts, at one time hoped that by putting down deep bore-holes an artesian-supply might be struck in large volume, as in Queensland, but the geological conditions

* Mining and Milling Gold Ores in W. A. *Eng. & Ming. Journal*, December 17, 1898.

do not seem to favour the probability of this expectation being realised, although it may be that sufficiently large quantities of water may yet be obtained on the Hampton Plains or elsewhere, comparatively close to the gold-fields, to compete with the supply which the Government have arranged to furnish. The Hampton Plains are some 20 miles from Kalgoorlie, and if anything like 500,000 gallons per day should prove to be furnished by the Cane Grass valley works (which it is asserted, there is some likelihood of obtaining), no doubt a private pipe-line may be laid down to pump it to Kalgoorlie.

When the Government scheme is carried to completion, however, there is no doubt that it will give an entirely new impetus to mining on the fields, by enabling many mines to increase their outputs and others which cannot now be worked at a profit to resume operations. In California, millions of gallons of water are "flumed" hundreds of miles to various mining camps, entailing enormous engineering difficulties, but this particular project is unique in the history of mining, as it provides for the delivery of 5,000,000 gallons of fresh water daily, which is to be pumped a distance of 328 miles, through 30-inch pipe, with an aggregate lift of 1,313 feet at the eight stations to be established along the line; the lifts generally being through short sections of the line, with long sections of falling grade between them.

The source of supply is the Helena River, which is in the Mt. Darling range, near the coast; a weir, which will dam the river back some 7 miles, forming a reservoir capable of containing 4,500,000,000 gallons, being under construction at Mundaring, about 26 miles from Perth, at an elevation of some 320 feet above sea-level. The weir is being built in a gorge and will be 720 feet long on top and 110 feet high near the middle, made of cement concrete, faced with ashlar work of very hard micaceous granite; the excavation for the foundations of the dam, amounting to 50,000 or 60,000 cubic yards, has been some time since completed.

The pipe line at each pumping station is to be broken by a reservoir, 20 feet or more in depth, holding not less than 2,400,000 gallons, into which the water will flow and from which it will be pumped to the next, the greatest distance between any adjoining stations being less than 70 miles. Between the second and third stations an extra reservoir 25 feet deep, with a capacity of 6,000,000 gallons, is to be located to reduce the head at this point by about 200 feet; otherwise the closing of the stop-valve at the third station would place about 36 miles of main under a head of 450 to 650 feet. The location of the pump-station is such that the head against which the water will be pumped will be

practically the same at each of the first four and second four stations, the object being to secure uniformity in the pumping machinery, of which there will be only two sizes proportioned to the two different lifts Triple-expansion engines with surface-condensers are to be used, and it is stated that economy of coal-consumption will, to some extent, be sacrificed to simplicity of design. The water, by this means, will be raised to the top of Mt. Burgess, an elevation of over 1,630 feet above sea-level, from whence it will be distributed by gravity to Kalgoorlie, Coolgardie, Menzies, and other camps.

At Coolgardie there is to be a service reservoir having a capacity of at least 24,000,000 gallons and a number of smaller service reservoirs, and 100 miles of 12-inch distributing mains are included in the project.

The contract for the pipe-line was let in October, 1898, to Messrs. Hoskins & Ferguson, the weight of steel involved (without jointing-rings) being 74,442 long tons. The coating added 3,867 long tons. The contract price for the coated pipe is about £13 per ton f. o. b. Falkirk, W. A., and the contractors are called upon to supply as many welded steel joints-rings as may be required up to 30,926 of such rings at the rate of £.2.6 delivered at Falkirk.

The peculiarity of this pipe is that it is made of steel plates fastened together with two longitudinal locking-bars, made by swelling the longitudinal edges of the plates, and bringing them together in grooves, made in the opposite sides of the bars. The bars are then closed on to the swollen edges of the plates by pressure. The contract requires 1,000 lengths to be 5/16 inch thick and 30 inches internal diameter, and 60,956 lengths to be 1/4 inch thick of similar size. The plates and bars are to be of open-hearth acid steel, the plates to be capable of withstanding a tensile strain of not less than 25 or more than 29 tons per square inch, with an elongation in 10 inches of not less than 20 per cent., and a contraction area of not less than 45 per cent.

The selection of this new form of pipe was decided upon, however, on what appear sound reasons, *viz.*, whilst the engineer's estimate for 330 miles of 30-inch spiral rivetted steel-pipe was £1,068,000, the contractors' tenders for lock-bar pipe came to only £998,000, against which the actual tenders for spiral rivetted pipe of 26, 27 1/2, and 29 inch diameter (which it was at first intended to employ) came to £1,220,000. Consequently the saving in cost thus effected admitted of employing a large-size pipe, without exceeding the engineer's estimate; and all rivets being done away with, as also the changes in the diameter of the pipe every 28 feet (which would have been caused by

placing the sections alternately inside and outside each other), the adoption of these pipes ought to decrease friction considerably, and effect a saving in pumping charges, which it is calculated will amount to some £10,000 per annum.

It is proposed to lay this pipe on timber bolsters or sleepers, hollowed to a depth of not less than 6 inches (to fit the under side of the pipe), placed on the ground, and although with a range of temperature of 75° F. the amount of expansion to be provided for is about ⅝ inch for every 100 foot length of pipe, as this is not likely to occur except if the pipes are emptied during extremes of heat and cold, it is expected that expansion joints placed every 120 feet will meet the difficulty. So placed, however, the pipes would offer but little resistance to motion and "creeping" might occur unless prevented, whilst in all curves the joints would have a tendency to move radially from the centre of the curve. To obviate such movements, 3 feet from the end of every fourth 28-foot length of pipe, three 12-inch pieces of angle iron 6 by 4 by ⅜ inch are to be double-rivetted to the under side of the pipe, to bear against piles or a mass of concrete, and piles of concrete blocks placed on the outer side of the pipe on curves.

Stop valves are to be used at the inlet to each reservoir, at the outlets of the pumps at every important depression, and at points not exceeding 5 miles apart. Scour-valves having openings 6 to 9 inches in diameter are to be placed on the under side of the main at every depression.

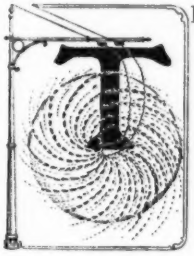
The plan of laying the pipe on the surface is not, as seems generally supposed, new in Australia, as to my knowledge water is pumped from the Burdikin River to Charters Towers in Queensland through a line of this description, built, if I recollect right, in 1888, which supplies the town with water. The reasons which have produced its adoption in this case were: 1, That in a line of such extreme length the question of leakage is important, and as small leaks from the joints and rivets of steel pipes, when subjected to strains caused by expansion and contraction, are certain to occur, they can be easily detected early and thus at once repaired; 2, decreased cost of laying; and 3, the fact that the soil along most of the line contains salt which would induce rust; 4, there is no prolonged frost to guard against, and no difficulty to be apprehended from wilful damage.

The estimated cost of the undertaking, which being carried out by the Public Works Department of West Australia, will amount to £2,400,000; the charge to be made for the water is variously stated at from 2*s.* 6*d.* to 3*s.* 6*d.* per 1,000 gallons.

TRANSATLANTIC COMMUNICATION BY MEANS OF THE TELEPHONE.

By Prof. M. I. Pupin.

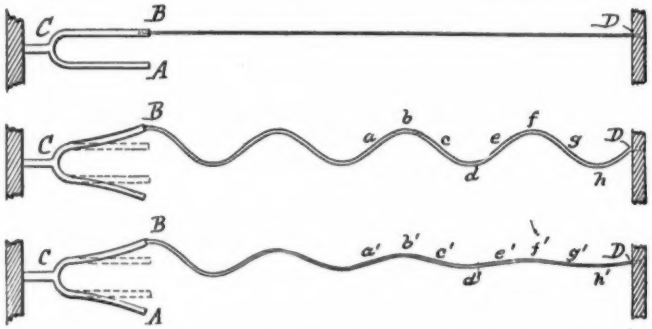
Ten years ago, in the first number of this Magazine, Mr. Herbert Laws Webb forecast the possibility of Transatlantic telephony. Dr. Pupin has just devised the effective means for accomplishing this end. It is a striking instance of success in tracing out a mechanical analogy in an allied field. It was well-known that vibrations travelled better in a dense medium than in a rare one. Sound carried better in water than in air; waves travelled further on a hard, heavy cord than on a soft, slack one. But to work out the analogy correctly—to determine the means and manner of loading an electric cable with inductance so that it should correspond to the densified medium and gain increased capacity for transmitting electrical waves—was a signal work of genius. In this article Dr. Pupin gives a general outline of the theory and experiment and a brief concluding measure of its significance.—THE EDITORS.



THE method of constructing cables and long-distance air lines for power transmission by electrical waves, particularly for long-distance telephony and telegraphy, is a practical application of the general mechanical theory of wave propagation over non-uniform conductors.* The main features of this theory can be explained by a very simple mechanical illustration. Consider the figure on the next page. A tuning fork has its handle *C* rigidly fixed. To one of its prongs is attached a flexible inextensible cord *B D*. One terminal of the cord is fixed at *D*. Let the fork vibrate steadily, the vibration being maintained electromagnetically or otherwise. The motion of the cord will be a wave motion. If the frictional resistances opposing the motion of the cord are negligibly small, the wave motion will be approximately that seen in Figure 2. The direct waves coming from the tuning fork and the reflected waves coming from the fixed point *D* will have nearly equal amplitudes, and by their interference will form approximately stationary waves. If, however, the frictional resistances are not negligibly small—if the string, for example, lies along a surface upon which it rubs as it vibrates, or if it hangs slack instead of being under tension between the tuning fork and the point of attachment—then there will be dissipation of the propagated wave energy. Hence the

* The first mathematical theory dealing with wave propagation of this kind was presented by Dr. Pupin before the American Institute of Electrical Engineers in Mar. 22, 1899. A more complete development of the theory was read before the same society in May, 1900.

direct and the reflected waves will not have equal amplitudes, and, therefore, their interference will not result in stationary waves. The attenuation of the waves is represented graphically in Figure 3. Experiments may readily be made with a cord lying along the floor, vibrated first in contact with the boards, then just free from them—first under little tension, then under higher tension. Further, experiments will show that, other things being equal, increased density of the string will diminish attenuation, because a larger mass requires a smaller velocity in order to store up a given quantity of kinetic energy,



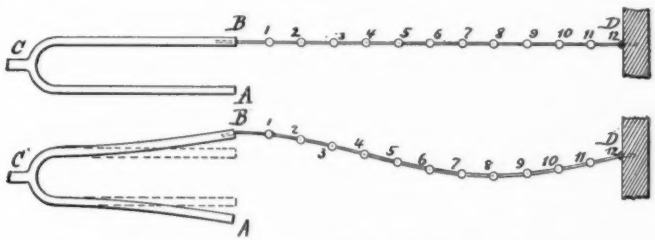
FIGS. 1, 2, 3. VIBRATION OF A CORD WITH AND WITHOUT FRICTIONAL ATTENUATION OF WAVES.

and smaller velocity brings with it a smaller frictional loss. This is a striking mechanical illustration of a wave conductor of high inductance. It should be observed here that an increase of the density will shorten the wave-length.

Suppose now that we attach a weight, say a ball of beeswax, at the middle point of the string, in order to increase the vibrating mass. This weight will become a source of reflections and less wave energy will reach the point *D* than before. The efficiency of transmission will be smaller now than before the weight was attached. Subdivide the beeswax into three equal parts and place them at three equidistant points along the cord. The efficiency of wave transmission will be better than it was when all the wax was concentrated at a single point. By subdividing still further the efficiency will be still more improved; but a point is soon reached when further subdivision produces an inappreciable improvement only. This point is reached when the cord thus loaded vibrates very nearly like a uniform cord of the same mass, tension, and frictional resistance. Such a loaded cord with a tuning

fork attachment is represented in Figure 4. Figure 5 represents the vibration of a cord carrying loads at proper distances apart.

The problem of finding the proper distance at which the loads should be placed is a definite mathematical problem of analytical mechanics, but unfortunately it was never solved. Experiments with cords of this kind will soon convince one that the distance between the loads should be considerably smaller than one-half of the wave-length of the wave which is to be transmitted, so that though a given cord may be properly loaded for some wave-length, it will not be properly loaded for shorter wave-lengths. It is impossible to load a cord in such a way as to make it equivalent to a uniform cord for all wave-lengths; but if the distribution of the loads satisfies the requirements of a given wave-length, it will also satisfy them for all longer wave-lengths. It should be observed now that the wave-length which is considered here is not the wave-length of the cord without the loads, but the wave-length which the frequency under consideration will have on the properly loaded cord, or what is the same thing, on a uniform cord of the same mass, tension, and frictional resistance as the loaded cord. This point is of fundamental importance, for the wave-length corresponding to a given frequency may and generally will be much shorter on the loaded cord than on the cord without the loads.



FIGS. 4 AND 5. VIBRATION OF A LOADED CORD.

A cord of this kind is a mechanical analogy to an electrical-wave conductor. The mathematical law in accordance with which such a cord moves is the same as that in accordance with which the electrical current is distributed over the wave conductor under the action of similar forces. The reason for that is not far to seek. We have the same reactions in both cases, viz.:—Kinetic or mass reaction, tensional reaction, and resistance reaction in the case of the cord, electro-kinetic reaction, capacity reaction, and ohmic resistance reaction in the case of the wave conductor. The mathematical form of these reactions is

the same in both cases, hence one is an exact analogy of the other—the mechanical a counterpart of the electrical. The loading of a telephone wire with induction coils, properly introduced, will increase its capacity for electrical-wave transmission. Wrongly arranged, they will decrease this capacity.

The insertion of inductance coils at periodically recurring points along the wave conductor or wire produces the same effect upon electrical-wave transmission as the distribution of the small loads along the stretched cord of Figure 4 produces upon mechanical-wave transmission along the cord. The mathematical theory of wave propagation over non-uniform conductors of this kind was given by the author in a paper before the American Mathematical Society and can be found in their Transactions for 1900. This theory is, of course, at the same time the mathematical theory of wave propagation over a loaded cord described above. The main object of this theory is to find an answer to the question: *Under what conditions are non-uniform conductors described in these two sections equivalent to their corresponding uniform conductors?* The answer which the mathematical theory gives to the question just proposed is definite. To formulate it introduce here a convenient technical term. Denote the distance between two consecutive inductance points, that is, the points at which the inductance coils are introduced, by l, and let the wave-length which is to be transmitted be λ. Now introduce an angle φ such that

$$\varphi / 2\pi = l / \lambda.$$

The angle φ shall be called the *angular distance* between the inductance points, or inductance sources. The angular distance 2π corresponds to the wave-length. The law which determines the degree of equivalence between a non-uniform conductor and its corresponding uniform conductor can now be stated as follows: *A non-uniform conductor is as nearly equivalent to its corresponding uniform conductor as* $\sin \varphi/2$ *is to* $\varphi/2$.

It is evident that φ is inversely proportional to the wave-length, so that for a given distance between the reactance points the degree of equivalence diminishes as the wave-length diminishes. If a wave of complex harmonic frequency, such as occur in telephony, be transmitted over a non-uniform conductor, then the action of the conductor will be different for the different components of this complex harmonic wave. If, however, the non-uniform conductor acts with sufficient approximation as a uniform conductor toward the highest important frequency of this complex wave, then its approximation to

a uniform conductor will be even higher for the lower frequencies and thus for all the frequencies of the wave. A numerical example will illustrate this point more clearly. It is well, however, to state more fully the meaning of the expression "equivalence between a non-uniform conductor and its corresponding uniform conductor." All that we can predicate of a wave of a given frequency is that it has a certain wave-length and a certain attenuation constant. Hence, if a wave of a given frequency has the same wave-length and the same attenuation constant on a non-uniform conductor as it has on the corresponding uniform conductor, then the two conductors are equivalent to each other. If these two quantities differ by, say, 3 per cent., then an approximate equivalence up to within 3 per cent. exists.

Consider now the following numerical example: A twin conductor, such as employed for telephone cables, has a length of 250 miles. Let its constants have the following values per mile:

Inductance = 0.
Resistance = 9 ohms.
Mutual capacity = .074 microfarads.

According to the high but definite standard which the New York Telephone Company employs, the limiting-distance of telephony over such a cable is 39 miles. According to the lower standard which is maintained in long-distance telephone work the limit would be 78 miles. The results obtained by me experimentally seem to verify these figures. I find that at a distance of 100 miles telephony over such a cable is very poor, in fact, impracticable, and at a distance of 125 miles impossible. It is proposed now to decrease attenuation and distortion over such a cable by the insertion of inductance coils at periodically recurring points. The attenuation constant β in this case is given by the formula

$$\beta = \frac{R}{\sqrt{2}}\sqrt{\frac{C}{L}}$$

Say that it is required to have $\beta = .015$. Assume that the introduction of the inductance coils adds 9 ohms per mile, so that $R = 18$ ohms. These values of R and C require $L = .56$ henrys. The attenuation factor at a distance of 250 miles would be $e^{-250\beta} = \frac{1}{40}$, (roughly). That is, 2½ per cent. of the current leaving the transmitting end will reach the receiving end. This is quite sufficient for telephonic purposes; but it should be observed that better efficiency of transmission could be obtained by making L larger. Notice now that the attenuation factor for this cable without

the coils would be, for a frequency of 600 p. p. s., roughly, $\frac{1}{25 \times 10^4}$ that is, with a given initial current, the current at the receiving end would be 6,000 times larger with the coils than without them.

The next step is to find the wave-length for the highest important frequency in telephony over a *uniform wave conductor* having $L = .056$ henrys, $R = 18$ ohms, $C = .074$ microfarads. The best telephone practice assumes that 750 p. p. s. is the highest frequency of any importance. The wave-length corresponding to this frequency over a *uniform conductor* of this description is obtained from the formula

$$\lambda = \frac{2\pi}{p\sqrt{2LC}} = 14.6 \text{ miles},$$

approximately.

Suppose now that at each mile we place a coil of inductance $L = .056$ henry and a resistance $R = 9$ ohms. The angular distance φ for frequency 750 p. p. s. of the non-uniform conductor thus obtained will be $2\pi / 14.6$. The degree of equivalence of this non-uniform conductor to its corresponding uniform conductor is measured by the degree of equivalence of $\sin \pi/14.6$ and $\pi/14.6$. Now $\sin \pi/14.6$ differs from $\pi/14.6$ by less than one per cent. of the value of $\pi/14.6$; hence for a frequency of 750 p. p. s. the wave-length and the attenuation constant on the non-uniform conductor will differ from the wave-length and attenuation constant on the corresponding uniform conductor by less than one per cent. of the values of these constants. Such a difference cannot be detected by any of the experimental methods which are at present available for investigating wave propagation. In telephonic transmission the ear could not detect it. For lower frequencies the differences will be even considerably smaller. Hence, the non-uniform conductor thus obtained will represent a uniform, non-attenuating, distortionless conductor for telephonic transmission.

It should be observed here that in the case of a submarine cable of say 2,000 miles the attenuation constant should be much smaller than the value of β given above, in order to have a sufficiently small attenuation factor. Now the capacity per mile of a submarine cable is about four times as large as the capacity of the telephone cable just described. Hence, both on account of the long distance and also on account of the much increased capacity, the inductance per mile will have to be much larger than in the case just discussed. But high inductance and large capacity will give a very short wave-length. For instance, if in the case of the submarine cable having six times the

capacity we employ an inductance six times as large as in the case of the telephone cable we shall obtain for the frequency of 750 p. p. s. a wave-length of only $14.6 \div 6 = 2.43$ miles. Hence, since the inductance coils will have to be placed apart at one-sixth of the distance employed in the case of the telephone cable, the distance between them will be about 880 feet. The distance between the inductance coils depends entirely on the circumstances of each particular case. But in all cases the rule given above contains the necessary and sufficient directions.

This rule and the method based upon it are recommended by my mathematical theory for the construction of distortionless wave conductors of high efficiency of transmission.

To determine how far the mathematical theory was confirmed by experiment, a so-called artificial cable was constructed. The cable had 250 sections, each consisting of a sheet of paraffined paper. On each side of this sheet was a strip of tinfoil. The resistance of this strip is approximately 9 ohms. The capacity of the condenser formed by the two strips is .074 microfarads approximately; 250 sections of this kind connected in series represent a cable of 250 miles in length, having a resistance of 9 ohms and a capacity of .074 microfarads per mile. The twin inductance coils consisted each of two coils wound on one spool 125 mm. diameter by 125 mm. high, and separated by a sheet of cardboard 1-64th of an inch thick. The coil when finished was boiled in beeswax at a temperature of about 280° Fahrenheit, in order to drive all the moisture out and insure good insulation. Each coil had 580 turns of No. 20 wire B. & S. The average inductance of one of these coils is .030 henry, and the mutual inductance .028 henry. Each coil, therefore, when connected into the line, has an effective inductance of .058 henry.

The connection of the various sections to one another either direct or through inductance coils is controlled by plugs. The plugs being in, the coils are short circuited, and the consecutive sections are connected to each other directly; the plugs being out, the consecutive sections are connected through the intervening coil. The former case gives the uniform cable, corresponding to the unloaded string; the latter case gives the non-uniform cable of 250 miles in length with an inductance coil inserted at each mile, corresponding to the vibrating string loaded with the waxen balls.

The object of the experimental research performed with this cable was to determine the electrical wave produced in it by the action of a harmonic electromotive force. A wave curve of this kind enables

measurement of the wave length and the attenuation constant, and comparison of the results thus obtained with the mathematical theory. The work was actually done and it was found that theory and experiment agreed very satisfactorily.

It was shown further that when the distribution of the inductance coils over the cable does not render the cable approximately equivalent to its corresponding uniform conductor, there will be serious internal reflections which will diminish the efficiency of wave transmission.

For this purpose the inductance coils were connected in groups of ten; one of these groups was inserted into the cable every ten miles; the total inductance of the cable was now the same as before, but the distribution was quite different. A simple harmonic e. m. f. of 260 p. p. s. was impressed upon the cable. The wave-length of a wave of this frequency on the corresponding uniform conductor was found to be 41.4 miles, so that the inserted inductance coils were apart at a distance which is equal to about one-quarter of the wave-length on the corresponding uniform conductor. The degree of equivalence between this non-uniform cable and its corresponding uniform conductor is very small. It was found that the attenuation in a cable loaded in this manner was *greater* with the coils than without them. In other words, coils introduced improperly are barriers to electrical waves and therefore they injure the efficiency of transmission.

These experimental results left no doubt as to the correctness of the prediction of the mathematical theory. Actual experimental tests with transmitters and receivers which were kindly put at my disposal by the New York Telephone Company, for which I feel very grateful to them, verified these predictions completely. Telephonic communication over the whole of the cable was carried on with perfect ease. Both the volume and the articulation of the transmitted sound were all that could be desired. If, however, the inductance coils were cut out and the cable used as a uniform cable, then the transmission was good up to 50 miles, fair up to 75 miles, impracticable at 100 miles, impossible at distances over 112 miles. Increased distance interferes with the transmission over the uniform cable, not only on account of the diminished volume of the sound transmitted, but also on account of the rapid loss of articulation. This manifests itself at first as an apparent lowering of the pitch of the voice just as the theory demands. My assistant's voice is of an ordinary pitch, if anything a little above the pitch of the average man's voice. When it was transmitted over 75 miles of the uniform cable (that is, the coils being disconnected from it) it sounded like a strong baritone. Over a distance of

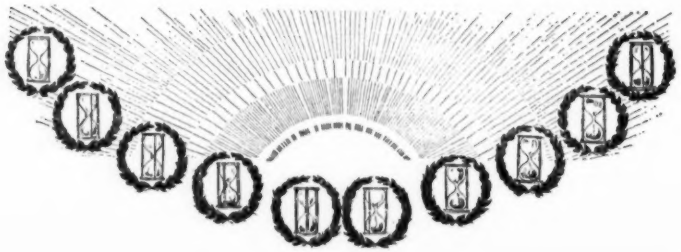
100 miles it becomes drummy (this is an expression borrowed from telephone engineers) that is was difficult to understand it, unless nothing but ordinary conversation was carried on and then very slowly, and the speaker had to put his mouth as close to the transmitter as possible and speak out as if he were addressing a big audience. At distances over 112 miles nothing but the lowest notes of the voice could be heard; the articulation was entirely gone. When the coils were all in, then no drumminess in the voice was noticed, and the conversation could be carried on as rapidly as one chose to do. I understand that in long distance work three galvanic cells of the same type of which I had two only were formerly employed by the American Telegraph and Telephone Company when they employed the old system of transmission.

The effect of internal reflection is illustrated even more strikingly by telephonic transmission than it is by the exploration of the waves. The same distribution of coils was used for telephonic transmission as described above in connection with the internal reflection experiments—that is, a group of ten coils each at distances of ten miles apart. A distance of a hundred miles of the cable was employed. Telephonic transmission over this distance was absolutely impossible, although the lowest note in the voice was transmitted quite vigorously, and sounded like the muffled beating of a big drum. Another distribution of the coils was now tried. The coils were divided into groups of five, and these groups were put into the cable at points five miles apart. Transmission over a distance of a hundred miles became intelligible, though with much difficulty; but it was not as good as over the cable without the coils. The drumminess was even more excessive in the former case than in the latter. One had to put his mouth very close to the transmitter, speak very slowly, very loud, and about very ordinary things, otherwise the meaning of the transmitted intelligence would not be caught at all. But if the same distance of cable was employed with the inductance coils placed one mile apart, as the mathematical theory suggests, then the voice of the sender sounded just as if he stood right before the receiving operator. It was not necessary to stand near the transmitter at all, in order to be heard at the other end. There was no difficulty in making the receiving operator understand even if the transmitting operator stood anywhere in the room at a distance of twenty feet or more from the transmitting instrument. The effect of the inductance coils properly distributed over the cable upon the efficiency of transmission astonishes even one like myself who have now worked for years upon and made myself

perfectly famliar with this fascinating problem of electro-mechanics. The inductance coils which I employed contained no iron. Coils with iron cores to be used for this purpose will have, of course, to be constructed in a perfectly definite way to work satisfactorily. I expect to bring this matter before the American Institute of Electrical Engineers in the near future. Suffice it to state now that such coils will be required in the construction of non-uniform submarine and underground telephone cables, on account of the much smaller volume per unit of inductance.

The practicability of such coils has been satisfactorily demonstrated in my laboratory, and coils of this kind are now in the course of construction, intended for loading overland lines of 1,800 miles in length. The method has been very thoroughly tested by the American Telephone and Telegraph Company on a line 715 miles in length, and found to work quite satisfactorily. The saving in wire on this particular circuit was about 64 per cent.; but much better results are obtainable. There is very little doubt about the possibility of telephoning by this method over a distance of 4,000 miles, using the present standard long-distance wires, over which telephony is now possible at a distance of 1,000 miles; and there is no reason to doubt the practicability of telephoning across Transatlantic cables properly loaded. The cost of such cables will not be more than 25 per cent. over and above the cost of the cables of the present type. Some mechanical difficulties will be met, of course, but they do not seem to be very serious.

Further, and by no means least important, is the obtainable improvement in telegraphy. A line which is reasonably good for telephony is excellent for rapid telegraphy. The means which would make conversation across the ocean possible would fit a Transatlantic cable for the use of systems of rapid telegraphy, enormously increasing its business capacity. In view of this gain, the additional expense of installation would be a trivial matter.



EDITORIAL COMMENT

OUR TENTH ANNIVERSARY.

Ten years ago, in April, 1891, the first number of THE ENGINEERING MAGAZINE was published. The anniversary is worthy of a notable celebration, not only because of the gratifying success which the Magazine has achieved, but especially because of the timely and telling service which it has been able to render to engineers and industrial managers the world over.

* * *

But I am prompted by weighty considerations to depart from the established custom of celebrating such an anniversary with a special number, an illuminated cover, and the attendant loud blowing of trumpets. The new century was greeted with our Works Management Number, which has scored a striking success because of the world-wide demand for a publication giving, within the covers of a single volume, some really notable examples of successful works management, and also clearly indicating the principles, the methods, and the mechanical equipment of the modern system of highly specialised production. In other words, it met a legitimate demand—it performed a use. And that, I hold, is the only justification for any special number of a Magazine devoted to the interests of "men who do things." For busy, practical men do not buy engineering literature to be entertained. They want information—"working plans available for immediate use," as one of my colleagues has happily phrased it.

* * *

Acting upon this principle, and inspired by an honest determination to have the Magazine render its constituency the highest possible service, I decided a year ago to make this anniversary memorable by publishing in one volume, alphabetically arranged like a dictionary, a complete descriptive Index to the world-wide range of current engineering literature during the five closing years of the Nineteenth Century. The work on this great publication has been progressing steadily, and is now nearing completion. But the magnitude of the task has proved so great that we are denied the happy coincidence of simultaneous publication with this number of the Magazine. For this occasion, therefore, I can only say that the prospectus of the work, showing sample pages, will be issued during the coming month, and within about ninety days we hope to be able to deliver the completed volume. Its definite aim will be to make all the really valuable literature of this fruitful period available for all time; and as evidence of the professional spirit which animates the work, I cannot do better than quote my colleague, Mr. Suplee, under whose personal direction the idea is being carried out. Writing in these pages recently, he said:

It is related that King George III. once made the remark: "I have had occasion to consult the best lawyers in my dominions, and the ablest of them can do no more than refer!" He might well have said the same of a wider subject than the law; and what would have been true at the close of the eighteenth century is a thousand-fold truer at the close of the nineteenth.

The Engineering Index enables the engineer to refer, with a fullness and promptness which without its aid would be impossible; for no matter how fully a professional man may know his standard works of reference, it is a physical impossibility for him to keep in touch with the latest and fullest form of professional information—the current technical periodical

press—except through the medium of such a record. With the completion of the third volume of the Index, now in course of active preparation, there will be placed in the hands of the engineer a retrospect of the work of the closing years of the century, which, unlike others to which reference has been made, will be of permanent value and usefulness, alike a record of the past and guide for the future.

* * *

But if this great Index volume is to be the enduring monument to the Magazine's first ten years' work, I am sure that our readers will also share the pride and pleasure that we feel in drawing attention to the remarkable continuity of plan, purpose, and method which have characterised the Magazine from the beginning. Thus, of the contributors to our first number ten years ago, Messrs. Atkinson, Saunders, Clarke, Going, and Allen are all once more represented in this initial number of our second decade. And then, as now, they treated subjects of foremost importance in the engineering and industrial world. Mr. E. E. Olcott. M. E., Mr. Edward P. North, C. E., and Mr. Peter T. Austen, Ph.D., F. C. S., were also among our original contributors, but pressing engagements rendering it impracticable for them to join our present company, their places have been worthily filled by the timely contributions from Messrs. Charleton, Christie, and Ford; while in Prof. Pupin's great invention, now described by himself, we have the realisation of an idea fully discussed in an article which formed a leading feature of our first number. This completes our programme for this issue.

* * *

It is also interesting to make record of the fact that, in the first prospectus of the Magazine, issued simultaneously with the appearance of the first number, I used the following language:

It is a Magazine giving the best thought of the best minds in the engineering and mechanical professions, and it is written for and read by men of affairs who are actively engaged in our greatest enterprises.

The writers have attained honourable celebrity in connection with the subjects which they treat, and being thus written by eminent men in the professions rather than by an individual editor, it is common ground upon which all meet upon a footing of perfect equality; and as such it is indispensable to the active man who desires to keep abreast of his profession.

Each issue also contains a complete review of everything worthy of note that has occurred during the preceding month in the entire field which the Magazine covers; and accompanying this is a complete list of every noteworthy publication that has appeared in the numerous technical papers published on both sides of the Atlantic. The latter feature alone makes the Magazine worth its cost to every man who has need to keep in touch with the times.

This reads so much like a prospectus of to-day, and so exactly describes the present plan and policy of the Magazine, that it seems nothing short of remarkable to find that ten years of varied and often trying experience in conducting a high-class publication for a world-wide audience of technical experts, has developed no sound reason for a radical departure from the original conception. The Magazine has indeed improved vastly in the character of the matter which it presents; the leading articles are selected with far more logical continuity; and the practical value of the great array of information which it presents each month shows a long advance over the average of earlier years. But in form, in typography, in method, and especially in central purpose, it is to-day substantially what it was in the beginning. And in view of this it seems a fitting occasion to say something of why I have been able to succeed in a field where my predecessor failed.

* * *

The first monthly magazine devoted to engineering science was established by Mr. David Van Nostrand, the founder of the widely known technical publishing house, The D Van Nostrand Co. In January, 1869, he issued the initial number of a publication which was entitled:

VAN NOSTRAND'S
ENGINEERING MAGAZINE

It was an octavo of standard magazine size, set in brevier type, two columns to the page, closely resembling our review department pages; and the subscription price was five dollars a year. During the first twelve months it averaged 96 pages each issue, then dropped to 80 pages, and so continued until December, 1886, when its publication was abandoned. Throughout the entire seventeen years it was highly technical in character, abstract mathematics and military science being largely represented.

* * *

The lessons of this experience were not lost upon me. I saw plainly that Mr. Van Nostrand was a successful publisher of technical books, rather than a professional editor; and that he had made the natural, but fatal, mistake of supposing that a current monthly magazine could carry a burden of abstract technicalities, interesting only to students and specialists, and properly belonging within the covers of text books. I also saw that the great modern school of scientific writers led by Darwin, Spencer, Huxley, Tyndall, and Büchner had wrought a revolution in thought *by simply making themselves clearly understood.* In the beginning, therefore, I confidently flung to the breeze these legends.

"Men who belong neither to the highest nor to the lowest intellectual spheres, often infer want of depth from perfect clearness. They find comfort and support in abstract and learned phraseology."—*Tyndall.*

"Disquisitions which cannot be understood by every educated man, are not worth the printer's ink that is spent on them. What is thought clearly can be expressed clearly."—*Büchner.*

And in the early prospectus graced by these quotations—mottoes which should be engraved upon every engineer's memory—I wrote this:

These names (a list of our contributors) sufficiently indicate the high level upon which the Magazine is conducted, and the peculiar force of its appeal to the great audience of intelligent men who are actively engaged in the varied industrial enterprises of our time. Such readers have neither taste nor time to pore over abstruse disquisitions. The bridge engineer is no more concerned with the technicality of the metallurgist's laboratory, than is the railway manager with the formulæ of stresses and strains. In like manner the mechanical engineer leaves electrical terminology to the electrician, just as an architect would consign bacteriology to the sanitary engineer. But skilled experts, all alike, meet on common ground with the man of business in demanding a straightforward, business-like statement of essential facts. The end to be accomplished, the principles involved, the cost of construction, the capacity when finished, the sources of income—these are all matters of first interest to all classes of intelligent men, and in the conduct of THE ENGINEERING MAGAZINE everything is subordinated to the single aim of meeting the requirements of this diversified, numerous, and world-wide constituency of practical men-of-affairs.

* * *

Again in 1897, when the European Edition of the Magazine was formally established, after a careful study of the exact requirements of the European field, I said, with much emphasis:

It is important to understand that the Magazine is radically different from every other technical publication. Instead of competing with any one of them, it gives a monthly digest of what is published by each and all of them. Instead of devoting itself to some special branch of engineering, *it is highly specialised* in the all-important work of recording the progress of engineering science *in all its branches* and *throughout the world.* Instead of imitating or duplicating the work of other journals, it has made for itself a distinct place in engineering literature. It has been able, therefore, to establish a position of world-wide influence and circulation, solely because it renders a needed and valuable service which no other journal more than pretends to afford.

Recognising, also, the intense and laudable patriotism of every British engineer, and seeing the necessity for giving the Magazine a permanent abiding place on British soil, as part and parcel of British technical literature, I took care to explain wherein the London edition would be localised and distinct from the American Edition, and "from the first page to the

last would appeal directly and positively to the interest of European readers." Then I went on to say:

But it must not be understood from this that the scope of the Magazine is to be limited by either national or geographical considerations. On the contrary, the *world is its field*, and to make the world's best engineering practice available everywhere is its central purpose. Every day gives proof that engineering science is not circumscribed by national boundaries. Every year sees an enormous increase in international trade—in the interchange of methods and appliances. All applied science is a matter of plain business—a matter of pounds, shillings and pence. "The largest yield at the lowest cost" is the motto of success, and the greatest engineer is he who first adopts and successfully applies the best that genius and invention have discovered—no matter whence its origin.

Obviously this is true Anglo-Saxon gospel—a gospel which every clear-headed man is proud to own. For with British commerce unfettered, and with her markets at home and abroad open wide in welcome to all comers, we have the realism of that grand philosophy which has proved that the fittest will surely survive. And what is the teaching? Great Britain is a very bulwark of political stability and security, and every day and hour sees her manufacturers solving the industrial problem by simply taking the best that America and Germany have to offer—in methods, in machinery, and in raw materials.

"For always in thine eyes, O Liberty,
Shines that high light whereby the world is saved;
And though thou slay us, we will trust in thee."
John Hay.

* * *

Happily, too, Britain's example is now hastening the dawn of a better day. America is fast coming to see that what she needs is, not paternalism and political meddling, but wider markets. And Germany's young Emperor, also, has suddenly "changed the *rôle* of war lord for that of the promoter of enterprise and the foster father of commerce." In short, as my colleague, Mr. Going, has eloquently written:

The action of the three great powers in China is a clear acknowledgement that the leaders of thought and action see their fundamental interests to be identical. The great commercial rivals appear as political allies. Antagonism wanes as emulation waxes. The theorem that one nation's ruin is another nation's gain, has gone into the scrap-heap with other dead dogmas of political economy.

The hero of the future is the captain of industry, not the captain of armies. The struggle is to produce the most, and most cheaply—not to destroy the most and the most quickly. The keynote of success, the secret of power, is economy—economy in production, in methods, in management. Before engineers and managers lies the duty of meeting the conditions—and the other great duty of using their influence and power in the affairs of the nation, so that justice and wisdom may govern the State at home and abroad.

* * *

Thus, at the end of ten years' work THE ENGINEERING MAGAZINE is proud of the record of having done much, not only to make current technical information available through its Index system, but, especially, to broaden the scope, to impart vital interest, and to attach public importance to the literature of engineering science. For to my mind industrial literature has now become more important than all others. Take out of the world we live in the work of Watt, Stephenson, Fulton, Morse, and Bessemer, and what would civilisation be? Little more than the Dark Ages left behind. Take out of the present and future the thrilling hope of such work as living engineers and inventors are doing, and what would the prospect be? Let thoughtful men answer. Verily ours is the literature of great men of the past whose thought has wrought a revolution in civilisation—the literature of living men whose work will emancipate the race by enriching the earth—the literature of those who think only to act—and in doing the world's most essential work, make all other things possible.

JOHN R. DUNLAP,
Editor and Publisher.

NEW YORK, *April, 1901.*

REVIEW OF THE BRITISH PRESS

Official Obstruction of Electrical Progress.

ATTENTION has been called in numerous instances, both in these columns and in leading articles in the Magazine, to the retarding influence which has been exercised upon the industrial progress of electricity in Great Britain by official conservatism. We now have a scathing paper by Professor J. A. Fleming in the *Nineteenth Century,* showing the stifling effect which official obstruction has produced, and calling for relief in no uncertain terms.

Rapidly reviewing the marvellous progress which has been made in electricity since 1870, Professor Fleming says:

"In 1870 the dynamo machine, by which an electric current is produced from mechanical energy, was still in process of evolution. The electric arc lamp was a laboratory instrument. The electric incandescent lamp, of which there are now four millions in use in London alone, was non-existent. The telephone was merely an inventor's dream; quadruplex and multiplex telegraphy were unsolved problems; the possibility of creating electric waves, though conceived by the genius of Clerk Maxwell, a mere theory. Hertz, world-famous for his experimental researches on their production, was a boy at school. Marconi, who has applied them in wireless telegraphy, was not yet born. Röntgen had not given the surgeon a new eye by which to see bones and bullets in the living tissue. Ideas on the subject of electric supply stations, electric tramcars, electric railways, electric transmission of power, telephone exchanges, the electrolytic production of caustic soda, bleaching powder, or the electrical production of pure copper and of aluminum, now all vast industries, had not arrived or had only floated in faintest outline as pleasant dreams through the minds of hopeful inventors. They were then all far off as realised facts."

Since 1870 Gramme has produced the continuous current generator, and Hefner-Alteneck, Zipernowsky, Ferranti, Tesla, Ferraris, and their successors have brought the generation of electricity to its present state of perfection.

Electrical storage has grown from the fundamental work of Planté and Faure; transformers developed from the ideas of Gaulard; arc lighting made commercially practicable by Brush, and incandescent lamps produced by Edison and Swan. The telephone was produced by Gray, Bell, and Edison, and the microphone by Hughes.

Close upon this pioneer work in electrical development came the enormous business development in connection with telegraphing, telephoning, electric lighting, electric traction, electric power-distribution, etc., until a whole world of new industry has grown up based entirely upon the commercial exploitation of electricity.

Bearing all this in mind, Professor Fleming remarks upon the meagre number of English names in this list of pioneers in electrical development, and maintains, most truly, that it is not from lack of ability. The truth is that it is from lack of incentive, or to put it more strongly, it is from deliberate destruction of incentive.

As a most conspicuous instance of official interference, Professor Fleming goes somewhat into detail into the manner in which the Post Office has succeeded not only in levying a toll of 10 per cent. upon the telephone receipts, but also practically blocking nearly every improvement in the electrical communication of intelligence, because of the entire monopoly which it holds. As he puts it: "The Post Office possesses the sole right to transmit intelligence by electrical means in return for payment, not merely as the art was then known, but by all and every method which the wit of man could or might through everlasting ages devise."

The telephone in Great Britain, therefore, has to pay a toll of 10 per cent., and the service it at the same time hampered by the opposition of the Post Office to the tele-

phone company's efforts to secure proper rights of way-leave.

The story of the development of wireless telegraphy is another example. For eighteen years the Post Office has been experimenting with the inductive system, only to succeed in communicating between points a few miles apart by the use of parallel wires greater in length than would be required to span the distance. In four years Marconi has succeeded in communicating across the channel over a distance of ninety miles and has made numerous successful applications of the electric wave system well-known to every one. With all this practical success in evidence the Post Office still delays in acknowledging or using the demonstrated system and continues "experimenting" with the older method.

Electric lighting is another case in point.

"In 1882 electric lighting began to be an industry, and the Board of Trade, in the person of its then President, the Rt. Hon. J. Chamberlain, deemed it necessary to provide that promising but infant industry with a complete suit of legislative swaddling clothes, in the shape of the Electric Lighting Act of 1882. Assuming apparently that the great aim should be to nip in the bud any tendency to the upgrowth of a monopoly rivalling perhaps those of gas and water, the Act of 1882, ironically termed an Act for 'facilitating' electric lighting, was formed to meet this fear. It provided in its notorious purchase-clause that a Local Authority or municipality should have power at the end of twenty-one years to purchase compulsorily an electric-lighting undertaking at the then value of its plant and works, without regard to goodwill or present or future profits. On this basis capitalists would have nothing to do with the public supply of electricity as a business, and hence for six years electric lighting in Great Britain remained in a torpid, semi-comatose condition. Then began an agitation for an Amendment Act. In 1888 Lord Thurlow, speaking in the House of Lords on the Bill for this purpose, remarked that, as a consequence of the Act of 1882, not one of the sixty-four Provisional Orders for electric lighting, granted by the Board of Trade up to that date, had been put into operation. Yet at that time there were 120 stations in the United States paying dividends of 6 to 14 per cent.

The Act of 1888 altered the purchase period from twenty-one to forty-two years. Investors then obtained a fair chance for the profitable employment of capital, and from and after that date electric lighting has advanced in the United Kingdom by leaps and bounds."

A similar case of throttling legislation has acted to choke off the development of electric tramways, a compulsory purchase clause at the end of twenty-one years at a valuation based upon the mere price of materials, plant, and works at the date of purchase effectively deterring investors from enterprise.

"Hence, whilst for fifteen years the business of electric traction in the United States has been in a position to command and nourish in its service the best inventive talent, we in Great Britain are only beginning to move. We find now that we have to go for much of our knowledge and for many of our materials and machines to the experienced inventors and manufacturers in the United States. They are past masters in the art; we are just learning the business."

"If electrical invention is not to languish in Great Britain, some reforms seem necessary. Public opinion must be brought to bear more strongly through the Press and Parliament upon the administration of Imperial and Local Governmental Departments which are in the practical control of electrical monopolies. The conduct of municipal bodies to new electrical enterprises must be continually criticised. A stronger public opinion must be created on the value and immense national importance of scientific research and invention. Professor Perry has recently emphasised this necessity in an eloquent address to the Institution of Electrical Engineers. All electrical inventions are based upon a scientific knowledge of the facts of Nature. One object of scientific research is to provide the necessary exact information which lies at the root of successful applications in the arts. The late Professor Huxley once declared that if a young Faraday could be purchased in the open market for the price of a first-class battleship, the purchase would be a bargain. For all we know he may he had for nothing, but we must first make an enivronment suitable to foster inventive genius, and not permit it to be repressed by educational or legislative conditions."

Metal Mining in India.

THE great importance of the mining interests of India renders the papers of Dr. John W. Evans before the Society of Arts, published in a recent issue of the *Journal* of the society, worthy of notice and comment, although space here is lacking for an adequate discussion of the subject. Indeed, Dr. Evans himself is obliged to limit his treatment to Peninsular India, and to omit reference to the whole question of the iron deposits of India.

After a brief notice of the geology of the country and some remarks as to the unimportant deposits of lead, zinc, tin, and silver, Dr. Evans refers to the long worked copper mines, and then passes on to his main subject, the gold mines of India.

There seems to be little doubt that the southern part of the peninsula is identical with the land from which the ships of Solomon brought gold, and evidences of ancient workings, both of auriferous sands and of deep workings, are many and important. Vast quantities of gold have doubtless been taken from these old workings, and as only a small proportion of it can be accounted for as plunder of conquerors and the export of commerce, much must still remain hoarded in all parts of the land.

The auriferous tracts of Mysore are discussed at length, both from the geological standpoint and also with regard to the rise of European mining in the district. In this connection the story of work of Mr. Lavelle, and the skill and persistence with which he and his successors, the Kolar Concessionaires, pushed the sinking of their shafts until the old workings were reached, forms a most interesting episode. From 1882, when the output was valued at but £38, down to 1889, with its record of £1,678,090, the total product of Mysore foots up £10,636,687.

Dr. Evans gives some space to accounts of the efforts to develope the Wynaad and the Chutia-Nagpur districts, showing how the brilliant hopes originally raised were doomed to disappointment, and then proceeds to discuss the future prospects of gold mining in India.

Intelligent forethought and scientific method are above all important. No surface reefs may be expected except those which were too poor for the ancient miners to work, and hence prospecting must be done by intelligent drilling, and the diamond drill may be used to advantage in this work. Modern methods of treatment should also be applied, the ore being analysed and the methods employed modified accordingly. In some instances the cyanide process may be employed to advantage, but frequently the pyrites should be concentrated on a vanner and smelted.

Commercial success demands that economy should be secured in every direction. The ores are not rich, fuel is dear, and the cost of labour is great. Mining materials imported from Europe are dearer in South Africa, on account of the higher freight to India, while at the same time the natives are prone to the excessive use of explosives.

An additional cause of expense is the necessity of sending the gold home to be refined. Formerly it was taken by the Indian mints, but an excessive accumulation of gold in the treasury compelled the government to offer less favourable terms.

If investors are careful to see that the values of mining properties are, as far as possible, tested before the purchase is completed; if moderate prices are paid to the vendors, if the mines are carefully and scientifically worked, and the expense reduced to the lowest point, we may hope even yet to see gold mining a prosperous industry, not only in Mysore, but even in some localities in the Wynaad, Bellary, Haidarabad, and in other parts of India.

Light Lathes and Screw Machines.

AN important department of modern machine-tool design formed the subject of a paper recently presented before the Institution of Mechanical Engineers by Mr. John Ashford, and from the interested manner in which it was discussed and the increased introduction of such tools in British workshops, the paper demands review and comment. Mr. Ashford begins by saying:

"Many changes have taken place during the last few years in the methods of machining in our various engineering establishments and manufactories—changes which are necessary in the march of progress, and which we must and do recognise as essential in order that we, as a country, may maintain our position in the manufacturing

world. These changes in machining methods usually accompany modifications in the schemes of works management, the object being to systematise the output of work, so that prime costs may be reduced to the lowest point, while the quality of the productions, as regards both accuracy of size and fineness of finish, may be all that can be desired. In order that these new schemes of organisation may be satisfactorily worked, and all requirements of the new order of things fulfilled, there has been a demand for machine tools which in themselves shall fit into the scheme, be more handy for their work, be capable of producing numbers of an article exactly alike, be automatic, where possible, in their action, and shall require little skilled attention. That the changes in themselves are great may be realised when we consider to what an extent milling processes have supplanted shaping and slotting, and, more especially, hand-finishing; how grinding is now used for finishing work that has previously been turned; and that at present automatic machines are being introduced for producing machine parts in quantities which had hitherto to be made by skilled men at a much higher cost.

In what manner these methods originated it is difficult to say; but in all probability they were first introduced in the manufacture of watches and clocks in large numbers; then in the production of small arms, sewing machines, typewriters, and the like; and later in the construction of cycles. Engineers have now without doubt recognised the fact that similar methods may be employed in the manufacture of larger machines, locomotives, and even bridges and ships. These changes have not been suddenly brought about, although to some it may appear so; but they are, in fact, the result of steady progress. To those who have not kept abreast of the progressive movements, the changes may have been forced upon their notice with unpleasant suddenness by the experience of foreign competition. Probably there are establishments with which some of our members are connected, where it is realised that alterations in the producing plant must be made; yet there is hesitation in making the heavy outlay necessary before they have thoroughly considered the matter, and are satisfied as to the results likely to accrue.

"That the matter is serious is evident from the fact that in certain manufactories whole shops have been cleared of their machines, and a complete new and up-to-date plant installed."

Mr. Ashford well says that the ordinary lathes with which manufacturers were satisfied ten years ago do not fulfil the requirements of the present day. The necessities of the present time demand machines which may be more smartly worked, be more handy, and cause less loss of time. Bearing these requirements in view, he enumerates the various conditions which must be met, both for the general lathe and for the turret lathe, emphasising the successive points by illustrations drawn from examples of machines by leading British, German, and American builders.

Space is here lacking to display and compare the machines presented in the paper, these comprising the tools of such well-known makers as Jones & Lamson, Lodge & Shipley, and Hendey-Norton, in America; Herbert, Ward, Humpage, Jacques & Pedersen, in England, and Pittler, in Germany, but the real force of the paper was not so much the comparison of the machines themselves, as a presentation of the necessity and importance of such machines in general.

In the course of the discussion the main points of criticism brought out were the superior strength of the English machines, and the superior convenience of the American tools. The question of automatic machines was well stated as follows: The ordinary lathe needs skill to run it; the automatic machine needs brains to start it, after which it can be maintained in operation by a less experienced man.

It is just this important feature that the modern machine tool must have to be successful, but it is a question as to how far the diminished skill requirements will be permitted to act in view of labour conditions. In the United States, where automatic machines are employed, and have been in full and most successful use for years, it is distinctly understood in labour circles that they are for the very purpose of enabling high-class work to be performed by comparatively unskilled labour. In this respect they bear much the same relation to non-automatic machines as the self-acting lathe, with its slide rest and screw-

cutting gear, bore to its time-honoured predecessor, the hand lathe. An important feature in the training of a skilled mechanic in the old days was the knowledge of how to chase screw threads with a hand tool, a form of skill now practically obsolete, even among the highest skilled mechanics. In the very near future the use of the skill and judgment of the machinist for the determination of a size or a fit must become equally obsolete, and for light work, at least, the machines described by Mr. Ashford are destined to play an important part in the transformation.

It must be remembered that a very important portion of the cost of the product is that due to the so-called "fixed charges," and that this must be apportioned in proportion to the time consumed in the production of the article. For this reason the rate of production affects the cost to a far greater degree than is indicated merely by the wage charge, and unless such automatic machines as Mr. Ashford describes are worked to their full capacity the great benefits obtainable will not be realised.

So far as the attitude of the manufacturer is concerned it is beginning to be realised that a machine is only a means to an end, and instead of inquiring minutely into the details of design the purchaser is content to leave such features to the maker, only demanding assurances as to the cost and quantity of the product. "Tell me how much it will cost by your machines to turn out so many thousands of the things I make; then I will reckon up what it would pay me to invest in this way, and we shall be in a position to trade."

American Competition.

In a paper recently presented before the Newcastle-upon-Tyne Association of Students of the Institution of Civil Engineers by Mr. George Harrison Sheffield, some reflections upon American competition are given with a degree of thoughtfulness, and freedom from prejudice, which makes it desirable to make brief discussion of them here.

Mr. Sheffield very justly compares the tendency of individuals toward fixity of ideas with advancing age, to a corresponding tendency on the part of nations. Their views become retrospective, and comparisons are based upon former standards. Such a frame of mind is by no means wise in approaching the subject of competition such as must be admitted to exist between England and America, so Mr. Sheffield goes straight to what he conceives to be the causes of American success. These he classifies under four heads: (1) The successful exploitation of the natural advantages of the United States. (2) The indisposition on the part of British manufacturers to adopt new appliances and to dispense with obsolete machinery; together with the difficulties which they have to face in the matter of railway freights and trade unionism. (3) The psychological characteristics of the American and English peoples. (4) The effects of the municipalisation of industries.

As an example of the natural advantages of the United States, the description of the great iron ore deposits of the Lake Superior district and the manner in which they are worked, as contained in the paper of Messrs. J. and A. P. Head is given, and it is shown that on January 1, 1899, the cost of a ton of pig iron was £1 less at Pittsburg than at Middlesbrough, while the cost of shipment to England was only about 13 s. per ton. This marked difference is due not only to the presence of the ore deposits, but also to the remarkable manner in which they are worked, using steam shovels of five tons capacity per lift, and capable of filling 25-ton wagons in 2½ minutes; with corresponding economies in hauling, reloading, and shipping. This is but one example of the successful exploitation of natural advantages.

The indisposition of British manufacturers to adopt modern equipment is asserted by Mr. Sheffield on the basis of his own inspection of many works. Firms advertising their ability to undertake important work are found to be quite unfit to carry out their offers economically, by reason of their antiquated tools and equipment. In many instances machines varying from 30 to 40 years old are pointed to with pride as having paid for themselves many times over and still being capable of doing good work. The practice of scrapping tools and other machinery as soon as it is found unequal to competition with later appliances is well known in the United States, and the

contrast in England in this respect is noteworthy.

As an example of the growth of a single branch of American mechanical industry attention is called to the fact that the annual output of four or five American locomotive works is nearly 5,000 engines, while it is a question if the annual output of all the locomotive works in Great Britain exceeds 1,000, although England should be in a position to supply all the demands of her colonies and dependencies. This is but one example and there are many others which might be cited.

As to the psychological difference between Englishmen and Americans, Mr. Sheffield calls attention to the wide sense of perspective and sanguine vitality which causes the American to seize quickly upon indications of coming changes and to act promptly and with a full grasp of the situation of affairs, not only in his own country, but in all parts of the world.

The stifling effect of municipalisation has been discussed elsewhere, but Mr. Sheffield makes some points which are too true to be omitted. Why, he asks, should a body of men, largely composed of retired tradesmen, be supposed to be gifted with a genius for municipal government? Are they by their education and training, and their conflicting interests, best fitted to grapple with the ordinary problems of modern municipal work, apart altogether from the larger responsibilities they wish to take upon themselves? Municipal progress should synchronise with industrial development, but that synchronisation is stultified if the definition of municipal progress is construed into meaning municipal training.

In conclusion Mr. Sheffield says:

"With the beginning of the twentieth century we have entered upon a new phase of industrial progress, and to the initiative of American manufacturers we owe the precedent for eliminating the individual units of ownership and the merging of them into homogeneous bodies known as trusts and combines. The result is apparently justified by the reduction of expenses and the standardisation of several classes of work.

"We are told that in this country it is impossible to adopt American methods, because they are suitable only to their surroundings. As our products will have to compete with theirs in the same markets, this statement is not altogether convincing. For if honest combinations in this country serve no other purpose than the suppression of obsolete works, they will at least have attained a step in the right direction.

"It would be selfish to suppose that we have a perferential claim upon the world's markets, although this was anticipated when the great principle of Free Trade was adopted. At that time, and for many years afterwards, we accepted raw material from other countries in exchange for which we supplied them with finished products, and so established what was virtually a monopoly. With the development of the resources of other countries there has arisen the natural desire to foster the growth of industry by converting those resources at home in order to avoid a loss of intermediate profit. Hence, the establishment of Protection and bounties in many of our former markets.

"To our Colonies we must look for the greater part of our future over-sea trade, and very recent experience has shown us that even they are not prepared, and rightly so, to penalise their prospects by paying exorbitant prices for the sake of patriotism.

"There is no lack of indication that we are approaching a time of commercial depression of unexampled severity; and during that depression I am convinced there will be a revolution in the methods of conducting many of our industries. The tenacity of purpose that has helped us to weather many industrial storms will, I hope, assist us in this case, and we shall emerge from that depression with a substantial improvement in the national welfare."

The Function of Specifications.

A RECENT editorial in the *Engineer* discusses in a rather pertinent manner the question of the draughting of specifications for engineering work by consulting engineers and engineers in the service of corporations, and in this connection proceeds to examine the real function which such documents are supposed to serve.

"A specification is supposed to be a statement of the nature of something which the engineer wants made, prepared for the guidance of the firm or individual who proposes to make it. The specification may be

a detailed description of the thing, accompanied by working drawings; or, alternatively, it may be merely a general indication of what the wishes of the engineer are. A very wide opening is given for abuse. On the one hand, the engineer may oppress the contractor; or, on the other hand, the contractor may defraud the engineer—or, more strictly, the engineer's clients. With these facts, however, we have nothing to do just now. We are about to suppose that the specification is honestly drawn, according to his lights, by the engineer, and that the contractors are willing to work to it in the spirit as well as the letter. Under just these conditions the specification may be most harmful. Roughly speaking, those concerned in specifications may be divided into two classes. The one consists of a limited number of professional men who are constantly drawing up specifications and placing orders; the other consists of a number of firms who carry out contracts under specifications."

Some engineers may be very competent scientifically, but very incompetent in dealing with their fellow men. This is shown by the fact that in many instances the engineer for a railway may design and specify a dozen bridges of nearly similar span, and yet make them all different, thus throwing away for his clients all the advantages to be obtained by repetitive work. Then again, no attention is paid to commercial sizes of material which may be in the market, and large increase in cost must necessarily follow.

It may be stated as a general truth that no one is fit to prepare a specification for bridge work who is not completely informed as to the best modern methods of building up bridges, the capacities of the tools employed, and the sizes of steel bars and plates that can be regarded as always in the market. That engineer will do best who knows how to avail himself of the materials and appliances most readily obtained; and that engineer will do worst who at every step demands special sizes, special materials, and special tools. In the present day these things are wholly unnecessary.

Another great defect in specifications is the minute description of the construction to be adopted, coupled with a requirement for a guarantee of performance. Thus, in connection with a specification for a pumping engine, the indicated power was stated. The dimensions of the cylinders, the pressure, the kind of valve gear, the ratio of expansion, were all given, and finally the contractor was to guarantee the consumption of steam per horse per hour. We need scarcely say that the order was never placed under that specification. An engineer is justified in stipulating for power and consumption; but he must leave the details of the way in which the steam is to be used to those who are asked to guarantee a given economy of fuel under heavy penalties.

These are only a few instances which warrant the engineer in stating that a specification is an edged tool, and that it may, when improperly handled, be as dangerous as it is useful when rightly employed.

Power Plant at the Glasgow Exhibition.

FROM a lecture recently delivered by Mr. Thomas Young before the Glasgow University Engineering Society some interesting notes are obtained regarding the power generating and transmitting exhibits at the coming Glasgow exhibition.

Steam will be generated at pressures of 120 pounds, and 160 pounds per square inch, a variety of boilers being installed. The lower pressure will be generated in four Lancashire boilers, using mechanical draft on the Sturtevant system, the gases being drawn through a Green economiser on their way to the discharge flue. Water-tube boilers are to be represented by two types, the Stirling, with small, nearly vertical tubes, and the Babcock & Wilcox, the latter being fitted with superheaters. One of the Stirling boilers will be equipped with a Vicars mechanical stoker, and the other fired with producer gas. The total boiler equipment is estimated at 5,000 horse power.

The engines will be of typical British design, there being two Willans & Robinson engines of 1,500 h. p. each, one attached to a Crompton and the other to a Schuckert dynamo. Engines will also be exhibited by Davey, Paxman & Co., Roeby & Co., Ruston, Proctor & Co., and Belliss & Morcom, and others, all of these driving direct connected electrical generators.

As at Paris, there will be little or no belting in evidence, the engines producing current by direct-connected generators,

there being two circuits, at 250 and at 500 volts pressure. The various operative exhibits will be able to receive current to operate motors for the power they require, and thus the whole question of power distribution is vastly simplified over what it has been at previous exhibitions.

The arrangements for varying the methods of firing, as well as the completeness of the equipment for weighing fuel, etc., should render it possible to make interesting experiments as to the various efficiencies under operating conditions.

Mr. Young gives many interesting details of the steam auxiliaries, including feed-water heaters, oil separators, pumps, reducing valves, etc., and it is anticipated that the entire power plant will be most complete and efficient. It is especially interesting to note that it is confidently asserted that the equipment will be in complete working order on May 7, the date set for the opening of the exhibition.

The Fulham Destructor Plant.

In a very complete description of the Fulham municipal electricity supply works in a recent issue of the *Electrician*, some interesting details are given of the destructor and steam raising plant.

Twelve standard Horsfall destructor cells are arranged in connection with six Babcock & Wilcox boilers, and are capable of efficiently destroying 120 tons of refuse in 24 hours. The boilers are equipped with mechanical stokers so arranged that either coal or destructor heat can be used, and as it is important that steam be maintained at all times, provision is also made for hand firing in case of emergency.

By the use of powerful steam jets a very intense combustion is maintained in the destructor cells, and the escaping gases are drawn over the hottest part of the furnaces, thus fully cremating them before they are discharged.

It is expected that the destructor gases will suffice to maintain a pressure of 160 pounds in the boilers up to a certain point, but it is not anticipated that they will suffice for the heaviest loads. Still it is estimated that the amount of refuse passed through the destructor per year will be approximately 40,000 tons, and its calorific value is placed at one-twentieth that of good steam coal, there being a saving, therefore, of the cost of 2,000 tons of coal yearly.

The capacity of the plant, in view of the growing demand for electric light and power, has been made considerably above that which will at first be required, the station, exclusive of spare plant, being capable of supplying a total of 30,000 eight candle power lamps.

The capital outlay amounts to over £100,000, and the contracts entered into are as follows:

Buildings, comprising destructor house, engine-room, offices, and transformer chambers, also a small building for public disinfecting purposes.....	£22,970
Refuse destructor, steam-raising plant, inclined roadway, and chimney shaft.....	16,760
Generating plant, including steam-pipes, condensing plant, mains, etc., and apparatus for the above-mentioned disinfector building...	46,000

Additional contracts for the supply of coal-handling plant, and meters, well-sinking, extra foundations, and engineering expenses increase the total to £108,000.

The installation of the electricity supply works at Fulham, in connection with the destructor plant, enables residences in the vicinity of that portion of London to be provided with electric light, and as the neighbourhood is filled with flats of all sorts and kinds, it is anticipated that there will be ample demand for the current, while at the same time the problem of refuse disposal will be wholly and satisfactorily solved.

The Action of Tides in Harbours.

THE various theories of the tides have been developed upon the assumption that the body of water under consideration is of indefinite extent, or in the case of a river, of indefinite, unobstructed length. Such conditions do not exist in fact, and with the possibile exception of the Amazon, there is no river or inlet of sufficient length to be influenced by more than one tidal wave at a time. The action of the tides in estuaries, harbours, and rivers, must therefore be studied by actual observation; and a very complete examination of the subject, by the well-known Director of the French Lighthouse Service, M. Bourdelles, appears in a recent issue of the *Annales des Ponts et Chaussées.*

M. Bourdelles examines briefly the theories of Airy, Saint-Vemant, Bazin, and Levy, and shows their insufficiency to solve the practical problems. He then takes up certain well-known cases, such as the transmission of the tidal wave of the Red Sea through the Suez Canal until it is dissipated at the Bitter Lakes; and of the tides in the bay of Morbihan, in Brittany, showing in both cases how the behaviour of the tides is almost entirely subordinate to the conformation of the basin in which the wave is propagated, varying, to a great extent with local conditions.

As might be expected, one of the principal causes of local influence is found in the friction between the wave and the channel through which it is propagated. This is especially manifested in the well-known case of the Bay of Fundy, between Nova Scotia and the coast of New Brunswick, where the retardation of the wave, due to friction, causes great differences of level to be produced within comparatively short distances.

Another cause for variation in the action of the tide is the slope of the coast. Examples of this are found on the ocean coast of France and on the gulf of Gascony. Here there is a gradual slope until depths of 150 to 300 metres are reached, when there is a sudden drop of 4,000 to 5,000 metres. The result is an accumulated tide upon the shallow sloping shores, making the rise greater upon those portions than at other points where the deep water comes close to the land.

Thus the equinoctial tide at the mouth of the Adour, where the deep water is close in shore, is 2.90 metres, while at Cordouan, not far to the north it is 4.90 metres, and at Ouessant it reaches 7 metres! The difficulty of obtaining accurate knowledge of the submarine coast conditions makes it impossible to draw exact conclusions, but the general influence of the change of depth is very apparent.

Another question to be studied is the action of conditions tending to vary the velocity of propagation of the tidal wave. This velocity is dependent upon the energy of the wave and upon the frictional resistance of the channel. When the depth is sufficiently great to render the frictional resistance negligible, the gradual narrowing of the channel and diminishing depth both combine to increase the velocity as well as the amplitude of the wave.

The propagation of the wave is modified by friction, the effects of which increase with the square of velocity of the current and inversely with the mean depth of the bed. These effects counteract the energy of the wave to a greater or less extent according to circumstances, or may neutralise it altogether.

In considering the action of the ocean tide upon entering a river, it is not always easy to determine just where the mouth of the river actually begins. The mouth, however, may be regarded as being at the point where the modification of the tide is perceived, this generally being the location where a bar is formed. When a channel is dredged through a bar it has little or no influence upon the propagation of the

tide unless the cutting is much wider than merely necessary for the purposes of navigation.

M. de Bourdelles examines the action of the tide with regard to the effect upon the river bed and banks, and shows, by reference to many examples the inconveniences resulting from a powerful and uncontrolled tidal action. In order to provide satisfactory navigable channels which shall maintain their depth and location it is most desirable that sufficient cross section, and especially sufficient depth, be provided for the volume of tidal wave. Sudden changes of direction or section are disadvantageous, and the ideal channel is one of ample depth, confined between parallel dikes, with the cross section gradually diminishing from below upwards.

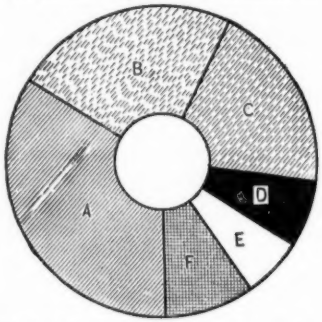
It is rarely that the ideal conditions can be attained in this, or indeed in any engineering problem; but with the exhaustive discussion of M. de Bourdelles as a guide, the nearest approximation which local conditions will permit may be determined, and in many cases the best lines for harbour improvement be worked out.

The Coal and Iron Industry in Russia.

THE gradual entrance of Russia into the industrial field of competition may be in some measure indicated by the development of the coal and iron industries, and for this reason a recent paper of Dr. Neumark, prepared after a journey of investigation in central and southern Russia, and published in *Stahl und Eisen*, demands review and comment.

Reliable information as to the beginnings of the Russian iron industry are lacking, but the earliest record is of furnaces in the vicinity of Tula, in central Russia, from which the industry spread to the Urals and to Siberia. In the time of Peter the Great the so-called College of Mines was officially established, and the industry became an object of special legislation.

Without going further into historical details, the growth of the two industries of pig iron and coal is given in tabulated form from 1880 to 1899, showing the total yearly output of pig iron to have risen in that time from 449,000 tons to 2,700,000 tons, an increase of 600 per cent During the same time the coal production had grown from 3,289,000 tons per year to 13,104,000 tons, or more than 400 per cent. Since 1899 the Russian iron industry has passed that of France and taken the fourth place, after the United States, Great Britain, and Germany. Comparing the rate of increase during the last fifteen years, Russia holds the first place and the United States the second. The general proportion of pig iron production of the



world for the year 1899 is shown in the diagram, the relative actual outputs and percentages being as follows:

	Tons.	Per cent.
(A) United States.....	13,839,000	34.10
(B) Great Britain.....	9,454,000	23.28
(C) Germany	8,029,000	19.77
(D) Russia	2,703,890	6.67
(E) France	2,567,000	6.32
(F) All other countries.	4,017,110	9.87

The rapid increase in Russian iron production has been mainly due to the remarkable developments in southern Russia, where the production has increased 1,000 per cent. in the ten years from 1889 to 1899, and where 50 per cent. of the entire Russian output is made.

The Russian ores are principally brown hematite and sphaerosiderite, and are mined in a very primitive fashion. The hematite occurs in banks and hills, from which it is dug by the peasants and hauled to the neighbouring furnaces, while the sphaerosiderite is found in the Jura clay, usually at depths of ten to fifteen metres, from which it is raised by shafts and windlasses. The ores run from 35 to 50 per cent of iron, and are easily reduced, and from the moderate content of phosphorus are well adapted for foundry use and for open-hearth steel making. In the Ural region are large deposits of magnetite containing as high as 66 per

cent. iron, as well as extensive beds of brown hematite, these nearly being in open workings and mined by cheap labour.

An important element in the development of the iron industry of southern Russia is that of the coal basin of the Donetz. The carboniferous formation as at present worked, lies on the right side of the valley of the Donetz, and extends east and west for a length of more than 350 kilometres, with a width sometimes attaining 150 kilometres, the area of more than 30,000 square kilometres exceeding that of all other European coal districts. The coal basin consists of three levels of massive limestones and sandstone containing numerous rather thin seams of coal, none being more than 2 metres thick, and ranging downwards to 60 to 75 centimetres (about 24 to 30 inches) in thickness. In some cases the seams lie close to each other, in other cases they are separated by more than 400 metres. The coal itself is of widely-varying quality, from the poorest, with more than 40 per cent. of non-combustible to the anthracite with but 2 per cent. The coke production naturally also varies, ranging from 50 to 90 per cent.

Dr. Neumark gives a detailed examination of each district, with tables of both iron and coal production, for which the original article must be consulted, and in concluding he gives a prediction concerning the future of the Russian iron industry Notwithstanding occasional reverses, the general rapid progress will undoubtedly be maintained. The consumption of iron per capita is yet far lower in Russia than in Germany, the former being in 1899 only 28.9 kilogrammes, and the latter 128.4 kilogrammmes. As the internal industries of the country are developed, the iron production will necessarily advance to meet the home market. The reduction in price with increased production will help to encourage the home consumption, and the adoption of improved methods of working will also contribute toward the same end.

Dr. Neumark takes occasion to comment upon the necessity for an acquaintance with the Russian language for the conduct of business with the interior of Russia, and notes that the bulk of the business is controlled by French and Belgians rather than Germans because of the unfamiliarity of the latter with the language.

The Sterilisation of Water by Ozone.

NEARLY two years ago reference was made in these columns to the process of MM. Marmier & Abraham for the removal of pathogenic bacteria from drinking water by the use of ozonised air. At that time the process was in an experimental stage, but further experience has demonstrated its practicability, and a paper recently presented by M. Abraham before the Société Internationale des Electriciens, and published in the *Bulletin* of the Société gives some interesting details of the process as at present operated.

After reviewing the earlier processes for water purification, such as boiling, filtering through unglazed porcelain, slow sand filtration, etc., M. Abraham shows that these are either too expensive, or only partially efficacious. Boiled water is flat and tasteless, and even with multiple effect or regenerative apparatus the cost is prohibitory on a large scale. Sand filtration, practically applicable, removes only about 95 per cent. of the bacteria, which, although a great proportion, still leaves sufficient to produce disease. Chemical methods of purification depend mainly upon oxidation, and hence the use of ozone appears to be the ideal method. The first experiments in the use of ozone for sterilisation were made in 1891 by Dr. Frölich, with the aid of Messrs. Siemens & Halske, at Berlin. The success of these experiments led to the appointment of Dr. Ohlmüller, of the Imperial Sanitary Bureau, to make an official report upon the sterilising effects of ozone. Exhaustive laboratory experiments with cultures of anthrax, typhus, cholera, etc., demonstrated that prolonged contact of the water with ozone totally destroyed the germs.

The experiments, however, were conducted only upon a laboratory scale, and although it was proved that ozone was entirely efficacious as a germicide, it was not considered practicable to effect the operation upon large volumes of water, mainly because of the difficulty of insuring complete contact of the water with the ozone. In 1893 ozone sterilisation was undertaken on a large scale by Baron Tindal and the chemist Schneller, in Holland, and the apparatus was shown at the Hygiene Exposition at Paris in 1896.

The difficulty with all attempts lay in two features: lack of concentration of the ozone, and imperfect contact of the water with the ozone. These points were taken up by Marmier & Abraham in 1895 and their first trial convinced them that success was to be obtained by employing a high degree of concentration of the ozonised air, by maintaining a sufficiently long contact of the water and the ozone, and by the effecting of a molecular contact.

The latter condition is obtained by using a form of absorption tower, similar to the Glover or Gay-Lussac towers, well known in industrial chemistry. The earlier attempts simply delivered the ozonised air into a tank in which the water was kept in a state of agitation, but this does not give sufficient thoroughness nor duration of contact.

The production of the ozone is effected by methods differing from those well-known in the laboratory by modifications required by the larger scale of operation necessary. When two plates, separated by a layer of air, are charged electrically with a sufficiently high difference of potential, there is produced a silent discharge, accompanied with the production of ozone. In order to prevent the formation of an arc there may be interposed a dielectric, usually a plate of glass, between the metal plates, and if a current of air be drawn continuously through the space between the plates it will be charged with ozone to a degree depending on the surface of the plates and the difference of potential. If such an apparatus is energetically operated the plates become heated, and hence it has been found necessary to make them hollow, with a circulation of cooling water passing to carry off the heat. The use of water-cooled electrodes appears to have originated with Tisley, in 1874, and was subsequently adopted by Siemens & Halske, and is a feature which renders the apparatus commercially practicable, as otherwise the required area of electrodes would be prohibitive.

The general arrangment of the plant at Lille is as follows:

The electrical current is generated by an engine and dynamo on the premises, and the pressure is then raised by a transformer to 30,000 to 40,000 volts, and delivered to the ozoniser. A fan is arranged to draw air through a dryer and deliver it through the ozoniser, where it becomes charged with 4 to 5 milligrammes of ozone to the litre, and then enters the absorption tower at the bottom, meeting in its upward travel the water which falls from above. The sterilised water is then pumped directly into the reservoir.

The report of the plant at Lille shows that all the pathogenic bacteria in the raw water were destroyed by the ozone, and most of the organic matter oxidised. A few germs of *Bacillus Subtilis* alone resisted the action of the ozone, this microbe also resisting a temperature of 110° C., but as this is altogether harmless to man or beast its presence is considered immaterial.

The cost of the process necessarily varies with local conditions, but it appears that one h. p. hour will produce 20 grammes of ozone, and that 5.8 grammes of ozone are required per cubic metre of air. The quantity of air required for a given volume of water depends upon the impurity, but may doubtless be kept at a minimum by employing sand filtration for the removal of the greater part of the bacteria, the ozone being used only for the final and complete sterilisation.

Electric Tramways in Germany.

THE usual annual statistical review of the progress of electric tramways in Germany, appearing in the *Elektrotechnische Zeitschrift*, gives a very comprehensive view of the progress of this important department of engineering industry.

The reports upon which the statements are based bring the record down to September 1, 1900, and include not only such roads as are in actual operation, but also those under construction and those projected.

The year included in the report shows excellent progress, many of the important plants reported as under construction in the previous yearly statement now being in active operation, besides which numerous new projects are under way. These various departments are very fully tabulated, with details giving date of opening, system of operation, whether overhead or underground conductor, or accumulator, length and gauge of track, number of vehicles, and

data concerning the power stations. For these the reader must be referred to the original, but a summary, particularly in comparison with the progress of preceding years, will be of interest.

The total number of centres of electrical tramway operation has increased from 88 in 1899 to 99 in 1900, a gain of 12.5 per cent. the track length (single and double) having been extended during the same period from 2,048 to 2,868 kilometres, an increase of 40 per cent. The increase in electrical output of stations has been nearly in proportion to the increase in track, having risen from 52,500 to 75,600 kilowatts, or 44 per cent. Nearly all of the tramways are supplied with curent from their own generating stations. It is, however, difficult to ascertain the exact proportion of the energy generated which is applied to tramway driving, since in nearly every case current is also used for lighting and other purposes. In many instances the station furnishes current both for traction and for general lighting, and there is a comparison of the two services and deduction of current used for purposes other than tramway driving. By taking the energy in kilowatts per kilometre of track, averaged from 70 tramways in which the current is used only for traction, a comparative estimate is made for those supplied by general stations, these results being probably quite near the truth.

The increase in the use of accumulators, whether for direct driving or for equalisation of load in generating stations, has not been nearly so great as in the previous year, showing a gain of about 25 per cent., instead of 164 per cent. The total generation of electrical energy in Germany, both for lighting and power, at the beginning of September, 1900, was 322,550 kilowatts, or about 440,000 horse power, being an increase of 38 per cent. over that of the preceding year. The general efficiency of electric tramway driving has not greatly changed, the mean of 70 roads, referred to above, being about 20 kilowatts per kilometre of single track, or about 15 kilowatts per motor car.

So far as distribution and pressure of current are concerned there has been little change. The overhead trolley construction, either with sliding or roller contact, is in almost universal use, although in some cities the mixed system of overhead trolley and accumulator is in use, notably in Berlin, where some underground conductor is also used in connection with the two preceding systems.

Only three cases are given in which the driving is wholly by accumulators, but two of these are sections of the main lines of the Bavarian State Railways, each between 50 and 60 kilometres in length.

But a single example of the third-rail construction is recorded, the Wannseebahn, 12 kilometres between Berlin and Zehlendorf.

The statistics show Germany to be decidedly ahead of other European countries in respect of electric tramway development, but as compared with the United States it is still far behind, there being only about one-eighth the track mileage. The rapid development in Germany, however, shows that the advantages of the electric tramway are becoming more and more fully appreciated, and there is every prospect that the extension of electric driving to main line service is being most seriously considered.

The Formation of Boiler Scale.

One of the most obstinate substances found in boiler feed water, so far as the formation of scale is concerned, is sulphate of lime. Not only is it of frequent occurrence, but the scale formed by it is stony, adherent, and difficult of removal. It has generally been assumed that sulphate of lime diminishes in solubility as the temperature of water is elevated, and it is frequently stated that it becomes practically insoluble at 140° C., or about 284° F. As a matter of fact, however, reliable data concerning this point have been lacking, and hence the study by M. Boyer-Guillon, in a recent issue of the *Revue de Mécanique*, with an introduction by M. J. Hirsch, is an important contribution to the science of steam engineering.

After a brief review of the limited amount of published information upon the subject, M. Boyer-Guillon proceeds to describe the apparatus and methods of experimental observation employed by him. The first device consisted simply of a small glass receptacle containing the solution of sulphate of lime suspended in a glass tube through which a current of steam was caused to

flow at a known pressure. The precipitation of sulphate of lime could then be observed in the inner receptacle, while the temperature was deduced from the pressure. This method was found to be defective because of the formation of a silicate of lime upon the walls of the glass receptacle, and also because it soon appeared that the precipitation depended upon the element of time as well as temperature. A more elaborate apparatus was therefore devised in which a solution of sulphate of lime could be subjected to heat for any definite time, while a special form of filter immersed in the solution retained the precipitated crystals, while permitting the liquid to pass. The result was checked by a chemical anaylsis of the liquid. The difficulty of filtering at the observed temperature and pressure rendered some ingenious devices necessary, and the pressures were read both on Bourdon gauge and on an open mercury column.

Without going into the interesting details of the observations, the general results may be given, as having an important bearing upon the purification of boiler feed water. In a general way the popular idea as to the diminished solubility with increased temperature was borne out, but experiments with temperatures up to 200° C. showed that entire solubility was not reached.

Starting at 100° C. the solubility was 1.945 grammes per litre, while at 200° C. the quantity dissolved was still 0.155 grammes of sulphite of lime per litre. As above indicated, however, it was found that the solubility for any temperature diminished with the lapse of time, or in other words, that time was required to effect precipitation. Thus while the solubility at 100° C. is 1.945 gr. per litre at first, it falls to 1.648 gr. after the lapse of 8 hours; a reduction of about 15 per cent., and a similar effect is produced at other temperatures. Plotting the results in the form of a curve, it appears that the rate of precipitation is somewhat more rapid at high temperatures than at lower, but in every case several hours are required to attain the stationary solubility for a given temperature.

Although M. Boyer-Guillon gives only his methods and results, some immediate practical conclusions may be drawn from them. It is often attempted to purify feed water by heating it in a separate vessel before passing it to the boiler. The temperature of exhaust steam is generally deemed sufficient to cause the precipitation of the carbonates of lime and magnesia, but higher temperatures, generally attained by the use of live steam, are found necessary for the more or less complete removal of sulphates. In view of the above investigations it is evident that most of the sulphate of lime will be carried forward into the boiler with the feed water unless sufficient time be given for it to separate. In proportioning such heaters and purifiers, therefore, it is important to compute not only the heating surface necessary for the transfer of the heat to the water, but also to make the capacity sufficiently great to allow the water to remain in the heater long enough for the precipitation to be completed. In any case this method of purification is shown to be only partially effective, and in the light of M. Boyer-Guillon's admirable researches previous opinions must be modified.

The Performance of Grinding Machines.

UNTIL a comparatively recent date there has been little definite information available as to the performance of various kinds of machine work, the proportions of tools being based mainly upon experience and imitation. The actual stresses and strains are even yet imperfectly known, and the relative values of different methods of removing material are often matters of individual opinion.

With improved appliances, however, it is possible to measure the effort exerted and compare it with the result obtained, in such a manner as to enable some measure of the true efficiency to be obtained for future similar cases.

This question forms the subject of an experimental study by M. Codron, of which the first portion is published in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, of which some points may be here reviewed.

Mechanical operations may be classified into Forging, including all methods of working which change the shape without removing any material, and Fitting by which definite dimensions are given by removing a portion of the material. M. Codron confines himself to an examination of the latter class, and, in the portion of his investiga-

tions at present under examination, discusses only operations of grinding, leaving the work of cutting and shearing tools for subsequent investigation.

The elements which characterize an operation are often very variable, and hence it is only possible to examine the general conditions, furnishing data and methods upon which special studies may be based.

Considering rotating grinding wheels, in which the piece to be worked is pressed against the periphery of the wheel, the result depends upon the velocity of rotation and the pressure upon the work, also upon the hardness and size of grain of the grinding material. While these conditions cannot be altogether reduced to mathematical expressions, yet it is possible to so arrange them as to render them in some degree comparable. The mechanical elements are very simple, consisting of the radial pressure of the work upon the wheel, determining the penetration of the grains of grinding material into the metal, and the tangential velocity of the grinding surface. The ratio of the pressure of the work and the tangential effort is called by M. Codron the "coefficient of attack," and may be used to compare the relative cutting power of various wheels. By combining this expression with the rotative velocity of the wheel, and with the density of the metal worked, a formula is deduced by which the quantity of metal removed for a given expenditure of mechanical energy may be computed.

Having thus stated in mathematical form the relations of the various elements under consideration, experiments were conducted in order to enable the coefficients to be determined for different operations and materials. The important question of the quality of the wheel employed as a grinding material was readily determined by changing wheels and maintaining all other conditions constant. The quantity of metal removed in a given time then became a measure of the quality of the wheel. Thus with a wheel of very good quality 110 grammes of metal were removed under certain conditions in 15 minutes, while a medium grade wheel, under the same conditions removed 55 grammes, and a poor wheel only a little more than 6 grammes! In like manner the relative quantity of metal removed for different materials, using the same wheel and the same operative conditions, enables comparisons to be made determining the relative adaptability of grinding operations for the respective metals. Another comparison of the behavior of various grades of emery wheels is found in comparing the weight of metal removed with that of wheel abraded. Judged in this manner the best wheel above noted removed 8 kilogrammes of metal in producing 1 kilogramme of dust, while the corresponding result for the medium wheel was 3.448 kilogrammes, and for the poor wheel only 1.625 kilogrammes.

M. Codron describes in detail the combinations of registering dynamometers and spring balances by which the data were determined in the various trials, and gives tabulated statements of the results which show clearly the value of such experiments. When the tabulated data are plotted in the form of curves, it is possible to see very clearly the influence which the various conditions exert, and some interesting conclusions may be drawn. In order to remove one gramme of wrought iron about 500 kilogrammetres of energy were required, or 500,000 kilogrammetres per kilogramme (about 1,640,000 foot pounds per pound), this being explained by the minuteness of the particles removed. These figures give some idea of the magnitude of the energy stored in the cohesion of the particles of iron. Comparing the energy recorded by the dynamometer with that actually utilised, it appears that the mechanical efficiency of a grinding wheel is good, attaining about 83 per cent., the losses being mainly in journal friction, some portion being doubtless also in the dynamometer.

An examination of the curves shows that the maximum efficiency is not obtained with the maximum pressure upon the work, but that there are relations between speed and pressure which give the best results, and which should therefore be observed in design. Reproductions of the diagrams of the recording dynamometer are given, which show in a most interesting manner the variations in action for different speeds and materials, and the whole forming a most valuable contribution to the data of machine design.

Subsequent papers will deal with the action of other forms of machine tools.

Clearance and Compression in Steam Engines.

At various times during the past three years, or in fact ever since the first announcement by Professor Dwelshauvers-Dery of the unexpected results of his experimental study of the effect of compression upon steam consumption, notice has been taken in these columns of the study which others have given to this important subject. The latest of these papers is one by Herr H. Dubbel in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, giving a review of all the important research work which has been done in Europe and America in connection with clearance and compression, drawing practical conclusions from the combined results.

Briefly, the original statement of Zeuner was to the effect that the injurious effect of clearance could be entirely overcome by compressing the exhaust up to initial pressure, the clearance space being thus filled with compressed exhaust steam at initial pressure before live steam was admitted. The experiments of Dwelshauvers-Dery upon the experimental engine at the University of Liége showed, on the contrary, marked losses with increased clearance and corresponding compression, which he sought to explain by the action of cylinder condensation upon the compressed steam. This position was contested by several well-known engineers, notably by Professor Boulvin, of the University of Ghent, who applied the temperature-entropy diagram to the published data, and showed that the heat exchanges did not correspond to the theoretical conclusions. A discussion by former Engineer-in-Chief B. F. Isherwood, U. S. N., also reviewed in these columns in April, 1900, while accepting the results of Professor Dwelshauvers' tests, advanced the theory that the losses were due, not to increased cylinder condensation, but to the increase in negative work due to compression.

Experiments by Doerfel upon a Corliss engine at the Radotin cement works, using widely varying degrees of compression, showed that the loss due to initial condensation was diminished by increased compression. Herr Dubbel gives a tabular abstract of the now famous experiments by Professor Dwelshauvers, and then follows these with the data and results of the experiments of Professors Barr and Carpenter at Cornell University, and of Professor Jacobus at the Stevens Institute of Technology. These latter two series of experiments, very carefully conducted by American engineers of wide reputation for accuracy and skill, show that for degrees of compression ranging from 11 to 35 per cent., bringing the compressed exhaust steam from 5/8 up to full initial pressure, the steam consumption per horse power was not materially altered.

Weighing all the conditions carefully, Herr Dubbel concludes that the experiments of Doerfel, Barr, Carpenter, and Jacobus are entitled to acceptance, and that there is little or no loss in steam consumption with increasing compression. The results obtained by Professor Dwelshauvers he can only explain as due to leaky valves and piston.

REVIEW OF THE AMERICAN PRESS

The Coaling of Warships.

THE question of coal is such an important one in connection with the efficient performance of warships that much attention has been given to it both by naval and civilian engineers, and many appliances have been devised to be used in the operation of coaling. A very full discussion of the whole subject appears in a paper before the American Society of Naval Engineers, by Lieut. Commander J. R. Edwards, U. S. N., and published in the *Journal* of the Society, from which the following abstracts are made. Nearly all the improvements which have been made in coaling appliances are intended to increase the speed of the operation, and as the speed with which coal can be delivered is limited by the facility with which it can be stowed, Mr. Edwards very properly makes some pertinent recommendations as to the best arrangements on shipboard.

The great difficulty is at the bunkers, where delays are sure to cause blockades, and Mr. Edwards examines at length the changes which he thinks advisable to enable vessels to receive and stow coal as rapidly as modern appliances are able to deliver it.

Vertical chutes are recommended in all cases, as inclined chutes clog very easily, bituminous coal readily choking at an angle of 45 degrees. An insufficient number of openings is also a cause of delay in coaling, and transverse bunkers, when possible, will also be desirable, although the latter are only practicable in a limited number of instances. A graphic account of the difficulties and hardships of coal trimming emphasises the plea made by Mr. Edwards for more openings and fewer bunkers.

The question of the actual handling of the coal is fully considered, whether from land, from barges, or from colliers at sea. Mr. Edwards advocates very strongly the importance of keeping reserve coal afloat. The number of handlings of the coal is thereby reduced, while at the same time the strategic advantages due to the possibility of quickly distributing to various ships are secured. It is very well put that if the United States government has been willing to pay $50,000 bonus for each quarter knot in speed above contract requirement, a corresponding saving in time in other lines should be equally valuable.

In regard to the use of patent transporters for ordinary coaling, Mr. Edwards is of opinion that there are many such which can be produced of various machinery supply houses, and that there is no necessity for tying up to some particular device for all places. Some pertinent remarks are made in regard to the important subject of the location of coaling stations. The risk of a supply of coal being "bottled up" so to speak should not be possible. The ports frequented by commerce naturally possess many advantages, but the possibility of their being closed in time of war must not be overlooked.

In time of war coaling stations should be near the base of operations, wherever possible. With this comes the question of the possibility of coaling at sea. Among the devices which have been made for this service various forms of barges equipped with conveying and handling devices are discussed, but these involve the close approach to the warship, a matter which is often impracticable.

A far more practical device is the Miller marine cableway, in which the collier is towed at a moderate speed by the warship, while the coal bags are delivered by a cableway over the intervening distance. The chief difficulty in this device, that of overcoming the variations in tension due to the pitching and rolling of the vessels, has been very successfully handled by Mr. Miller, and a very complete account of the trials with the collier Marcellus and battleship Massachusetts will be found in the issue of THE ENGINEERING MAGAZINE for February.

1900. The Miller cableway is to be given an exhaustive series of trials in the British navy, which will probably decide the question of its adoption there.

"This coaling question grows in importance as the subject is carefully considered. It concerns the Navy too much to be ignored, and therefore the sooner the question is met the better it will be for the interests of the service. The fact must be apparent that we are weak in coaling facilities on many vessels. If necessary, therefore, large expenditures should be authorized to make desirable changes. This may be a troublesome question, and yet as one beholds the great strength of the British navy and studies its past history, he is impressed with the fact that one of the causes which has produced its predominance has been the moral courage of its administrators in meeting rather than avoiding troublesome questions.

"In the solution of this coaling question, primary consideration must be given to the location, size and character of the bunkers, and it should be realized that getting a sufficient supply to the fire room is only a little less important than getting the coal into the bunkers.

"In the consideration of this question, the greater tendency has been to provide for the reception of coal on the deck of the warship. There has been neither too much time nor money expended in improving matters there, and it is even regrettable that increased opportunities to improve matters in this respect have not been given our commanding officers. It is more important still, however, that changes be made in the warship itself. If for a time improvements in the bunker arrangements can be considered as the most important phase of this question, then we shall meet with a degree of success in coaling ship that will make the evolution less unpleasant and much more satisfactory. And while effecting improvements on board the warship, we should look to the question of securing colliers and barges that would answer our requirements.

"This subject will only be accorded the consideration that it merits, when a board of officers of high rank shall carefully consider the matter in all its bearings. There is not a bureau chief at the Navy Department whose time is not already taken up, and therefore, this work should be carried on by a special board presided over by some senior officer who has commanded warships of various descriptions, and who by experience knows of the discomfort, difficulties and demoralization attending the coaling of warships.

"However distinguished, able and competent an individual may be to give expression of opinion upon technical matters, it is a fact that individual views and recommendations never carry the weight that goes with the deliberate report submitted by a board of experts. The report of a board implies a consensus of views, of at least a majority of the members, and such a conclusion is founded after free discussion which is sure to have shown up the various phases of the matter.

"If the report of a board is often a compromise, it generally commands increased support for that reason. It certainly obliterates all the extreme views and prejudices of the individual. One has only to recall to mind the work of the several Advisory Boards, the Ordnance Board, the Armor Plate Board and the present Construction Board to note the thoroughness with which such boards have entered upon their duties. And with this experience it can be confidently expected that an inestimable benefit would accrue to the Navy from the deliberations and conclusions of some future Coaling Board."

Modern Appliances in Railway Construction.

In a recent paper on heavy railway construction in Wyoming, presented before the American Society of Civil Engineers, and published in the *Proceedings* of the Society, Mr. J. I. Boggs gives an interesting account of some important work on the line of the Union Pacific Railroad. It is not the present object to go into details of this work at the present time, but rather to comment upon the large amount of construction work which can be done with modern power machines, especially in localities where skilled labor is scarce and expensive, and where time is limited.

The particular work under consideration was the running of a new connection in order to lower the elevation of the highest summit on the road, this including a tunnel

of 1,800 feet in length and some very heavy grading, the total being 1,254,548 cubic yards, of which there was 312,257 cubic yards of solid granite excavation.

At the altitude of the work, about 8,000 feet above sea level, the season is very short, the snow ending only at the beginning of June and returning in September. It was therefore found necessary to work night and day, and an electric light plant was one of the first portions of equipment constructed. With this was also a compressed-air plant, and much piping and wiring for both.

On the section particularly discussed by Mr. Boggs, this being about four miles long, there were in operation eight steam shovels, and fifteen locomotives, with trains of 10 to 18 cars each, and many rock drills and other machinery.

As a specimen of the rapid manner in which heavy work was accomplished, the Dale Creek fill may be mentioned, this involving the filling of 475,000 cubic yards of earth, and being completed between June 8 and December 1. Other rapid pieces of heavy work which may be noted were an embankment 900 feet long, containing 110,000 cubic yards, executed between May 24 and October 20; also a 60,000 yard excavation, of which 86 per cent. was solid rock, completed between June 16 and December 31.

While there was probably nothing very extraordinary about the work, it does show the wonderfully short time in which an immense amount of work in railway grading can be accomplished with modern appliances and methods under difficult and discouraging conditions. The difficulties were increased by reason of the worthless and thriftless class of men which constituted a large proportion of the labor available. The wages paid were $2.25 per day to muckers and drill helpers, and $3.50 per day to drillers, the foremen receiving $125 per month.

The Development of the Rotary Transformer.

THE advantages of alternating currents so far as conditions of economical transmission are concerned are generally conceded, but for a great variety of uses the continuous current is preferable. At the same time a change of pressure is in most cases desirable, and hence the transformer by which these changes are accomplished is a very important piece of electrical apparatus.

The whole subject of rotary transformers, including their history, theory, and characteristics, forms the subject of a paper by George W. Colles, this paper forming a thesis presented at the Columbian University, and published in the *Journal of the Franklin Institute.*

The various kinds of transformations are classified into four groups according as the transformation is effected in respect of pressure, in respect of kind, in respect of frequency, and in respect of phase relations, there being varieties under these according to the nature of the currents.

Mr. Colles gives in his paper numerous illustrations, mainly taken from original patents, and treats exhaustively of the various types, but we have only space here for his analysis of the five principal types, leaving the reader to the original paper for further details.

The first, or rectifier type, is far the most ancient, dating back, according to Thompson, as far as 1838, and being in common use in 1869, when they were used for the field magnets of self-exciting alternators. This apparatus can hardly be called a transformer in the proper sense, as it contains no inductive or other coils, being nothing more than a rotating commutator, whereby the pulsations of the alternating or polyphase current are commuted and rendered unidirectional, or, on the other hand, the direction of a continuous current is periodically reversed. In the former case the rectifier must be rotated synchronously by a donkey motor. A commutator of this sort is easily devised, and a number have been put on the market; but the device is crude and at best a makeshift, as no truly constant current can be produced, especially from a simple alternating current; on the other hand, a true alternating current is not produced by reversing the poles of a continuous current circuit. The main defect of this class of devices is, however, the common one of excessive sparking, owing to the fact that the circuit must be periodically broken at each reversal to avoid the alternative of short-circuiting the primary mains. The best known of these devices is perhaps the Pollak rectifier, which takes the current only from the tops of the waves of electromotive

force, and so insures greater uniformity, though at the expense of continuity. This machine has been used in the Ferranti station at London to charge a battery circuit.

The inductorium type is characterized by a series of induction coils, which may or may not be stationary, arranged in a circle and having their primary and secondary coils, one or both, connected to the respective segments of a commutator; the apparatus is not, in general, self-rotative or self-regulating, as in our common motor-transformer, but must be rotated by a donkey-motor or other external source of power. One or two commutators are used, according as a direct and alternating or two direct currents are wanted. In this class there are three well-marked subclasses:

(1) The stationary independent coil type, in which each induction coil is wound upon a separate core, and separately connected to the commutator or commutators through slip-rings. This, the oldest of transforming devices for direct currents (if we except the rectifier), has proved, in the hands of two ingenious French inventors, one of the best, if the fatal defect of sparking can be overcome.

(2) The stationary ring type, in which the separate induction coils are now wound together all upon one ring, which has two independent sets of coils wound thereon Gramme fashion, and connected to the commutator or commutators through slip-rings.

(3) The rotating ring type, identical with the former, except that to avoid the slip-ring connection and possibly to give stability to the rotation, the induction ring is mounted on the commutator-shaft. The "dynamotor" has not been reached, as no external fields are provided.

In the motor generator type is included the very simple device of an independent generator coupled to a motor on the same shaft, or otherwise mechanically connected to it. Starting thus from an entirely different basis from either of the preceding, the two following types have been successively evolved.

In the dynamotor type the two independent machines of the preceding type are merged into one—usually a single armature, sometimes two armatures, but always in one field, and always with independent primary and secondary coils; its use being practically confined to continuous currents only, with a commutator for each coil.

Proceeding still one step further in the same lines, we reach the true rotary transformer; in which we have one machine, one armature and one coil only in that armature—in short, a dynamo of the ordinary drum or ring-wound type, but provided with two sets of connections to its armature coil, one of which *must* be a set of slip-rings for an alternating or polyphase current.

It should here be noted, that we have not taken the steps leading from the motor-generator to the rotary transformer type without serious sacrifices; for the first was at the expense of regulation, the second at the expense of a pressure transformation. So doubtful is the balance of advantage in favor of the rotary transformer, in fact, that even to-day the motor-generator is preferred in many cases, and it has not infrequently happened that, proving unsatisfactory, transformers have been taken out and replaced by the old motor-generator type.

American Slag Cements.

THERE has been so much said pro and con about the merits and disadvantages of cements made from furnace slag, that the paper by Professor W. K. Hatt, presented before the Indiana Engineering Society, containing data and results of many tests of such cements, may well be welcomed. Since a portion of the controversy has been as to the definition of a "Portland" cement, Professor Hatt's definitions may be here repeated. The crucial distinction appears to be in the calcination of the product to a clinker. When the cement is made by calcining a mixture of slag, sand, and limestone it may properly be called a Portland cement. A slag cement is a cement made by grinding a mixture of pulverized granulated slag and slake lime, this mixture having been made without applied heat.

The paper contains tables giving the chemical composition of the cements tested, together with data and results of the tests, these results being also graphically plotted. So far as tension and compression tests are concerned, the mechanical strength appears very favorable, although not all are equal to the best Portland cements.

One of the best American slag cements, at the end of a year, gave a strength of

above 550 pounds per square inch. The results given in the present tests at the end of 90 days are 507 lb., 483 lb., and 217 lb., respectively for neat cement, 1 to 1 of sand, and 1 to 3 of sand.

The appearance of slag cement is characterized by a delicate lilac color, in some cases almost white. When cement is made from slag by a process involving roasting, the cement is of a dark color like that of ordinary dark colored Portland cement. It has not the coarse or gritty feeling which characterizes most Portland cement. It works fat, sets slowly and passes ordinary tests for permanence of volume.

A pat of slag cement exposed to the air has to be well covered to prevent the surface from cracking. After drying out it will exhibit discolorations (yellowish or brown), whereas the pat hardened under water will not exhibit such discolorations. The characteristic color of the fracture of a water hardened briquette is green, but when the briquette dries out the fracture becomes white. The writer has noticed this green color, with a subsequent change to white, in the case of a well-known American Portland cement, and also the discoloration in the pat. This indicates slag adulteration, or else that there was not a sufficiently oxidizing flame in the kiln. The green color is due to the presence in slag cements of a percentage of sulphide of iron, or sulphide of calcium. This sulphide becomes oxidized on exposure to the air and changes color. Slag cements usually contain from 0.5 to 1.5 per cent. of sulphides.

It is this tendency to oxidation on exposure to the air which is destructive to mortar made of slag cements containing sulphides, and makes it necessary to use the product in underground situations or the interior of thick walls. A parallel test of briquettes hardened in air and water should be made to check up the presence of sulphides. This disintegration does not occur in case of all slag cements, and it is not a necessary defect.

The European slag cements which set finally in 6 or 8 hours seem to be more slowly setting than the American cements, which take their final set under the 1-lb. needle, in from two to three hours.

In the case of Portland cements, quicklime exists after burning and grinding, and air slaking or ageing is required. Often these Portland cements are sent out too new, the lime being masked temporarily by sulphate of lime. Since in the case of slag cements the lime is completely hydrated, no such danger exists of blowing or swelling; and they are said not to need any ageing. They are also said not to deteriorate on storage.

The presence of a considerable amount of metallic iron in slag cements serves at times as a means of detecting the adulteration of Portland cement with slag. If a magnet is passed several times through these cements, a considerable amount of this metallic iron will cling to the magnet. This amount, however, is variable, sometimes amounting to 0.33 per cent. and at other times only 0.1 per cent.

One element of value in the slag cement is that owing to its light color it is said not to stain masonry. This statement has been contradicted. Its specific gravity is considerably less than that of Portland cements; it ranges near 2.8, whereas Portland cements range near 3.10.

Water Purification in Washington.

MANY large cities are now becoming aroused to the fact that pure water supply must nearly always be secured by purifying the water, and not by expecting to secure and maintain an originally pure supply. The principal question to be considered is the proper method of purification.

In many cases there is a contest between the so-called "mechanical" system and the slow sand filtration systems of purification, and the decision is often based upon local considerations. Recently the city of Washington has had under consideration the purification of its supply of water, and as has already been remarked, the respective merits of the mechanical and the slow sand systems came up for consideration. The mechanical system, using a coagulant and then filtering under pressure, was advocated by Lieut. Col. Miller, U. S. A., to whom the matter had been referred by General Wilson, while the Medical Society of the District of Columbia, in the report of a committee presented to the U. S. Senate, came out strongly for slow sand filtration.

The matter was finally referred to three well-known experts in the matter of water

purification, Messrs. Rudolph Hering, George W. Fuller, and Allen Hazen, and their report, published in a recent issue of the *Engineering Record*, contains some interesting matter in respect to the proper use of the two methods.

It is a mistake to assume that either method is in itself appropriate, and the importance of ascertaining the conditions in each case is emphasized.

The character of the raw water is often an element of controlling importance in deciding a question of this kind. Generally speaking, sand filters are best adapted to purifying waters that are not extremely turbid, and mechanical filters have marked advantages in the purification and clarification of waters which for considerable periods are very turbid.

Viewed in this respect, the water of the Potomac is especially to be considered. Its average annual turbidity is about 80 parts of suspended matter in the million, which permits successful sand filtration, while after heavy rains the water becomes more turbid than any which has been successfully purified by slow sand filters in America. Although the turbidity could be materially reduced by subsidence there are times when it would not be possible to afford adequate preparatory treatment by this method, it being estimated that such periods might amount to one month in each year. The result of these investigations was a recommendation of the establishment of a complete system of slow sand filtration, with the auxiliary works which may be necessary for preliminary sedimentation, and with arrangements for the use of a coagulant for a part of the time. This, as it will be seen, is something of a compromise between the two systems under discussion, and as the raw water varies at different parts of the year to conform to the applicability of the two methods, this conclusion appears most reasonable.

An interesting portion of the report, and one upon which possibly more might appropriately have been said, was that relating to the waste of water. This matter of waste is so closely bound up with that of purification that it appears in nearly every case where filtration is under consideration, and where the large volumes of water to be treated form such an important element.

In the case of Washington the experts say:

"In this connection we beg to call attention to the large waste of water in Washington, and to suggest the advisability of taking measures to limit such waste. One of the most effective means of doing this is by the use of meters; and we recommend that they be placed on all public buildings at once, and on private services, when deemed necessary, as rapidly as practicable."

A general popular objection to the introduction of water meters is the fear that public health will suffer because of the efforts of the poorer residents, from motives of economy, to stint themselves in the use of water. While this argument is readily met by the adoption of a reasonable minimum charge, below which no reduction in payment could be obtained, there is another point to be considered, namely, that the public health is far more likely to be affected by the use of impure water made necessary because of the impossibility of purifying the immense quantity demanded and wasted. The supply considered by the experts in the case of Washington was 75,000,000 gallons per day, a quantity which, as they say, is sufficient to supply all legitimate needs of a population much greater than the present one.

With the introduction of meters such a supply would be ample for a long time to come; without them doubtless additional supplies and additional purifying plants will be demanded before long.

The Fortification of the Isthmian Canal.

THE question of the neutrality or otherwise of any canal which may be cut to unite the Atlantic and Pacific oceans was discussed in an address recently delivered before the American Academy of Political and Social Science, by Col. Peter C. Hains, U. S. A., and some of his more important conclusions may be noted here. It will be remembered that Col. Hains was a member of the Isthmian Canal Commission, and is therefore in a position to speak with especial information upon the subject.

So far as the nature of any fortifications are concerned, Col. Hains disposes at once of the idea that any land fortifications along the line of the waterway could be of any

importance. The real control of the canal would lie in the waters about the entrances. The nation that controls the adjoining seas will, in time of war, control passage through the canal, no matter which one has possession.

While a canal cannot be satisfactorily defended along its line, it is peculiarly susceptible to damage. A few resolute men could disable it with little danger to themselves. This danger of being temporarily disabled is a serious one even in a war with a weak naval power. The destruction of a lock or embankment, which could be accomplished with a few pounds of dynamite, would bring about a total suspension of navigation for an indefinite period.

Considering the actual military value of the canal itself, Col. Hains shows that it must be considered valuable only as a shortened line of communication. It would be of no use as a base of communication, and would not be able to compete with railways as a route for transportation of munitions of war and troops. Its value would be for the conveying of ships from one coast to the other, and for such purpose it should always be open. As a line of communication it would be badly located when considered in a war with a superior naval power, for instead of being in a protected position behind the main line of defence, it would be out beyond the main skirmish line.

The real function of the canal, in the opinion of Col. Hains, would be fulfilled by making the waterway neutral. It could not then become a prize of war, nor would an army be needed to protect it, nor a fleet necessary to maintain open communication through it. It has been said that the neutrality of the canal would permit Great Britain to send ships through it in event of a war with the United States, but even that is doubtful. Some time might be gained to a British fleet by such action, but the risk in so doing would hardly render it justifiable.

According to Col. Hains, the most desirable end to be attained would be an arrangement by which the regions of the canal and large areas of the sea at each terminus should be exempted from the operations of war. The larger the areas of neutrality the better, and Col. Hains himself suggests arcs of circles of one hundred miles radius as boundaries. Should a foreign power attempt to violate the neutrality, the United States could destroy the canal, and thus would hold command over the situation in any event. As Great Britain and the United States together would be most deeply interested in the use of the canal, it seems as if they should be able together to cause some such agreement to be adopted. In concluding, Col. Hains expressed himself as of the belief that in the existing status of the naval powers of the world, a neutral canal would be more useful to the United States from a military standpoint, than one controlled by a military power.

Hydraulic Excavation.

HYDRAULIC mining is a term that nearly every one who has heard of gold mining in California knows, but the tremendous power of jets of water under pressure to disintegrate earth, gravel and rock can only be fully appreciated by those who have seen the transformation which the operation has made.

A paper recently presented before the Engineer's Club of Cincinnati by Mr. Latham Anderson, and published in the *Journal of the Association of Engineering Societies*, gives some interesting data concerning the history and growth of hydraulic excavation, and although the process is now forbidden for mining purposes, he suggests that its capabilities for moving earth for engineering purposes have not as yet been fully appreciated. In mining, the jet of water is used to break down solid banks of earth in order that the gravel may be disintegrated in form for washing out the gold, and the result has been to demonstrate the manner in which the method may be used to move the material under favorable conditions.

Two examples of the action of hydraulic mining in California are given to show the capabilities of the process, viz., the North Bloomfield, in Nevada county Cal., and the Spring Valley, at Cherokee, Butte county. The capital invested in the North Bloomfield was $2,500,000. To gain outlet for the tailings into the nearest canyon, a tunnel 7 by 9 feet, 6,900 feet long, had to be cut through solid rock. The sluice line was over 2 miles in length and 6 feet wide. The "bank" or auriferous gravel deposit was 400 feet deep and 600 feet wide, the company

owning a mile and a half in length of this deposit. A 6-inch giant was used under a 500-foot head delivering 32.8 second feet of water and developing nearly 1,690 horse-power; and a 7-inch nozzle under a 250-foot head, delivering 31.54 second feet and developing about 1,560 horse-power. From 15,000 to 18,000 cubic yards of gravel were washed away each day of twenty-four hours.

The Spring Valley bank was about 400 feet in height. The bed rock tunnel was much shorter, but to obtain a dumping ground the company had to purchase over 700 acres of valuable farm land. At the time of the writer's visit in 1882, they had buried this land 12 feet deep with tailings, were expecting to add three feet to this depth, and still would be under the necessity of buying more land.

In the case of an engineering plant the moving of the earth is the main and only object, and hence the loosening and delivery of the material only demands attention, and much of the carefully constructed work of the gold mining hydraulic plant is not needed.

It is a mistake to estimate the cost of a hydraulic excavating equipment for engineering purposes from data taken from mining practice, since in the latter case the main object is to secure the gold, the movement of the earth being a means to that end. At the same time such engineering plants as have been constructed for hydraulic work are usually inferior to the great hydraulic mining plants in the following particulars:

First. In volume of water.

Second. (Usually) in amount of head or pressure.

Third. (Probably in most localities) in not having a natural or gravity supply and pressure.

But, on the other hand, we have the following advantages over any and every mining plant:

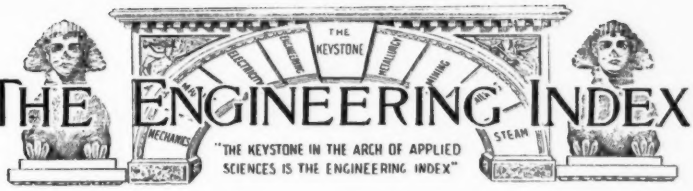
First. We may use cheaper boxes and sluice line.

Second. We avoid the expense of all the costly gold-saving devices and appliances—*e. g.*, costly bottom paving in the sluice line, undercurrents, box-riffles, retort house and the loss of at least four days' time each month in "cleaning up" (collecting amalgam) and in repairing sluice line.

Third. We save the interest and sinking fund on the capital invested in the huge dam and reservoir, and in the scores of miles of main ditch.

Fourth. The outlay, in railroad work especially, will be much smaller for giants, pipe line, tools and machinery for the cut than in mining.

Mr. Anderson gives data of a number of instances in which hydraulic excavation has been successfully employed in dam construction, filling, excavating, etc., and emphasizes the great economy attending its use



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *m.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly, New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Bascule Bridge.

Bascule Bridge Over the Chicago River at Clybourn Place, Chicago. An illustrated description of a bridge that is a type of several to be built in Chicago and vicinity. 5500 w. Eng News—Jan. 31, 1901. No. 39092.

Boston, U. S. A.

The Charlestown Bridge, Boston. Illustrated description of a bridge for carriages, street railways, and a double-track elevated railway, having plate-girder approach spans and a 1,200-ton swing span 240½ ft. long and 100 ft. wide. The unusual swinging, braking and latching appliances are fully described. 2000 w. Eng Rec—Feb. 9, 1901. No. 39232.

Bridge-Building.

Bridge-Building — Past and Present. Editorial on the development, noting progressive types and structures of interest. 2000 w. Engng—Jan. 25, 1901. No. 39164 A.

Concrete.

Low-Level Concrete Bridge Over the Mary River, Maryborough, Queensland. Alfred Barton Brady. Abstract of a paper read before the Inst. of Civ. Engs. of Gt. Britain. Illustrated detailed description of the bridge and method of construction. 3500 w. Eng News—Feb. 14, 1901. No. 39261.

The Concrete Bridge at Goat Island. Illustrated description of a concrete-steel bridge with spans from 50 to 110 ft. long, a stress diagram of the largest being given. The construction of the bridge was extremely difficult, owing to the current. 3000 w. Eng Rec—Feb. 16,1901. No. 39314.

Drawbridge.

The New Middletown Drawbridge. H. G. Tyrrell. Illustrates and describes a highway bridge in Conn., 1,300 ft. long, with a 26 ft. roadway, and provision for two 6 ft. sidewalks. Beside the street traffic it carries an electric railway line. 1600 w. Elec Wld & Engr—Feb. 16, 1901. No. 39323.

Erection.

A Novel Method of Bridge Erection Without Falsework. Extract from a recent paper before the Inst. of Civ. Engs., by C. F. V. Jackson, describing the design and construction of a railway bridge in Queensland, Australia, presenting a novel plan for dispensing with falsework. 1000 w. Eng News—Feb. 21, 1901. No. 39385.

European Bridges.

The Aesthetic Characteristics of European Bridges. Editorial, with the first of a series of views of notable bridges, selected by E. M. Wheelwright, who has made a study of this subject. 350 w. Eng Rec—Feb. 2, 1901. No. 39129.

Failures.

Failures of Bridges and Bridge Members. A discussion of the causes of failure of highway bridges and exceptional instances of strength of pin-connected structures. With illustrated letter describing failure of bridge at San Mateo under a drove of horses. 1500 w. Eng Rec—Feb. 16, 1901. No. 39313.

Plate-Girder.

A 103-Ton Plate Girder. Illustrated description of a four-track plate-girder bridge, 111 ft. long and 12 ft. high, having unusual rocker bearings, web reinforcement and floor details. 1000 w. Eng Rec —Feb. 2, 1901. No. 39132.

Rail Bearers.

Strength of Rail Bearers. Editorial discussion of past and present practice, calling attention to cases of interest. 1800 w. Engr, Lond—Feb. 8, 1901. No. 39371 A.

Strengthening.

Strengthening Bridges on the Gothard Railway (Einige Brückenverstärkungen der Gotthardbahn). Emilio Lubini. Giving illustrations and computations of the methods by which a number of lattice girder bridges on the Gothard railway have been reinforced. Two articles, 3800 w. Schweizerische Bauzeitung—Jan. 19, 26, 1901. No. 39451 each B.

Superintendence.

The Superintendent of Bridges and Buildings—His Duties and Responsibilities. Onward Bates. An address before the St. Louis Convention. 3500 w. Pro of Assn of Ry Supts of Bdgs & Bldgs—Oct., 1900. No. 39160 D.

Suspension.

A Novel Suspension Bridge. M. S. Parker. Illustrated description of a contractor's bridge consisting of wire cables drawn taut and covered with a light frame track, for use in filling a ravine. 500 w. Eng Rec—Feb. 2, 1901. No. 39131.

CANALS, RIVERS AND HARBORS.

Barge Lift.

Barge Lift at Foxton, Leicestershire. Illustrated description, with statement of the advantages of the lift over locking.

600 w. Engng—Jan. 25, 1901. No. 39-163 A.

Canals.

American Isthmian Canals. I. The Topography and Hydrography of the Isthmian Region is discussed by James Christie. II. The Engineering Features of the Nicaragua Route, by Edwin F. Smith. III. The Panama Route, by Louis Y. Schermerhorn. Maps. 7500 w. Pro Engs' Club of Phila—Feb., 1901. No. 39238 D.

Method of Cementing the Irrigation Canals of the North Riverside and Jarupa Canal Co. E. Duryee. Brief illustrated description of the method adopted in plastering with cement the canals named. 600 w. Eng News—Feb. 21, 1901. No. 39386.

Shall a Canal Be Built From the Lakes to the Sea? William G. Raymond. An argument against the construction, urging that the enterprise is unnecessary and unjustifiable. 2000 w. R R Gaz—Feb. 15, 1901. No. 39298.

The Canals of Canada. Waldon Fawcett. Information of interest concerning the Welland and the St. Lawrence Canals. Ill. 1800 w. Sci Am—Feb. 9, 1901. No. 39210.

The Hennepin, or the Illinois and Mississippi Canal. Henry Fox. An illustrated description of the construction work, with an account of routes surveyed, the development of the country, and the reasons for the undertaking. 3200 w. Wis Engr—Jan., 1901. No. 39311 D.

The New Panama Canal Proposals. Discusses the reasons why the United States government favor the Nicaragua route, and the work being done by the new Panama Canal Co., and urges British interest in the Panama project. 3300 w. Engng—Feb. 1, 1901. No. 39285 A.

The Proposed Ship Canal to Connect the Great Lakes and the Atlantic Ocean. James H. Brace. Reviews the surveys made and reports of various routes. 5000 w. Wis Engr—Jan., 1901. No. 39309 D.

Canal Feeding.

The Pumping Plant for Feeding the Rhiner-Marne Canal (Pumpwerk zur Speisung des Rhein-Marne-Kanales). J. Hermanuez. Showing the arrangement of turbines and electrically-driven centrifugal pumps. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 2, 1901. No. 39-435 D.

Canal Traction.

See Electrical Engineering, Power Applications.

China.

The Development of the Kiautschou District (Das Kiautschougebiet und seine Entwickelung). A description of the harbour of this German-Chinese treaty port. 5000 w. 1 plate. Glaser's Annalen—Feb. 1, 1901. No. 39441 D.

Docks.

Conneaut Harbor Ore Docks. Illustrated detailed description of this property and its management. 4500 w. R R Gaz—Feb. 22, 1901. No. 39501.

Dockyards.

Equipment and Methods of the Indian Dockyards. A. C. Bowden. Discussing especially the Bombay dockyard, and showing the successful operation of European methods in India. 3000 w. Engineering Magazine—March, 1901. No. 39471 B.

Dredges.

Sea-Going Hydraulic Dredges for the East Channel Improvement, New York Harbour. Brief illustrated description of two of the largest and most thoroughly equipped dredges ever constructed in America. 1400 w. Eng News—Feb. 14, 1901. No. 39258.

Puget Sound.

The Coming Industrial Empire of Puget Sound. D. B. Bogle. An examination of the great advantages of the harbours of the Northern Pacific coast of the United States, and the conditions which may insure their development. 5000 w. Engineering Magazine—March, 1901. No. 39470 B.

River Improvement.

Straightening the Mohawk River. Review of report by S. E. Babcock, who has recently surveyed this river and believes the improvement can be made. 3000 w. Fire & Water—Feb. 9, 1901. No. 39268.

CONSTRUCTION.

Carpentry.

The Music Hall of the Pan-American Exposition. Illustrated description of a structure 150 ft. square, with a main dome 130 ft. high. The wooden framing, fully described, has many unusual details of heavy carpentry. 2200 w. Eng Rec—Feb. 9, 1901. No. 39235.

Coffer-Dam.

The Accident to the Chambly Dam. Illustrated description of a coffer-dam constructed to permit the operation of a hydraulic power plant pending the replacement of a washed-out section of a masonry dam. 600 w. Eng Rec—Feb. 16, 1901. No. 39316.

Crystal Palace.

Engineering Details at the Crystal Palace. An illustrated description of work representing the practice of a generation ago by men of professional eminence. 3000 w. Engr, Lond—Feb. 1, 1901. Serial. 1st part. No. 39280 A.

Cupola Framing.

The Cupola of the Reichstag Building in Berlin (Die Kuppel des Reichtagshauses in Berlin). A. Zschetzsche. An exhaustive mathematical investigation of the stresses in the framework of the octagonal cupola upon the Reichstag building in Berlin. Three articles, 2 plates. 12000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 25, Feb. 1, 8, 1901. No. 39444 each B.

Foundations.

The Pneumatic Caisson Foundation for the Broad Exchange Building, New York City. A description of foundation work, interesting for its extent and the difficulties resulting from the short time available for carrying it out. Ill. 2800 w. Compressed Air—Feb., 1901. No. 39243.

Road Improvement.

The Cost of Wagon Transportation and of the Maintenance of Earth Roads. I. O. Baker. Abstracts of two papers presented at meeting of the Illinois Soc. of Engs. & Survs. Deals with actual conditions and prices. 3600 w. Eng News—Jan. 31, 1901. No. 39096.

Roads.

The New Road From Enzeli to Teheran. A description of a portion of an important enterprise carried out under Russian influence in Persia. Map. 3200 w. Engr, Lond—Feb. 1, 1901. Serial. 1st part. No. 39282 A.

Tunnelling.

Concrete Work on the East Boston Tunnel. An abridgment of parts of the report of Howard A. Carson. Describes the method of constructing a subaqueous tunnel of 23 ft. clear diameter with concrete walls. 2100 w. Eng Rec—Feb. 2, 1901. No. 39133.

Hydraulic Shield Tunnelling on the Melbourne and Metropolitan Sewerage System. A paper by George Henry Dunlop, read before the Victorian Inst. of Engs. Illustrates and describes work notably on account of the number of sewers of small diameter built in this way, the novel methods adopted for lining, and the variety and extent of the soft ground passed through. 8000 w. Eng News—Feb. 7, 1901. No. 39207.

Underpinning.

Underpinning High Masonry Structures. Illustrated description of the method of raising a large stone court-house, and of strengthening the foundations of an 80-ft. brick chimney. 1100 w. Eng Rec—Feb. 2, 1901. No. 39134.

MATERIALS.

Paving Brick.

Paving Brick Specifications and Tests. A report of the standard specifications adopted by the Illinois Society of Engineers and Surveyors, with a discussion of the reasons for their choice. 2000 w. Eng Rec—Feb. 9, 1901. No. 39234.

Requirements of Brick for Paving Purposes. H. E. Beasley. Read before the Illinois Clayworkers' Assn. Quotes from specifications for brick pavements to be used in Peoria, Ill., and discusses the value of the tests required. 1500 w. Brick—Feb. 1, 1901. No. 39176.

Preservative.

The Preservation of Structures in Metal, Wood, or Stone (Préservations des Constructions en Métal, Bois, au Pierre). L. Kirsch. A description of the protective coating devised by Zonca, of Venice, with accounts of tests. 3000 w. Rev Univ des Mines—Jan., 1901. No. 39418 F.

Timber.

Woods of the Philippines for Electrical Purposes. R. G. Mayse. Information concerning the large supply of wood suitable for telegraph and telephone service, and some of the native work. Ill. 1800 w. W Elect'n—Jan. 26, 1901. No. 39071.

MEASUREMENT.

Instruments.

Notes on Mine-Surveying Instruments, with Special Reference to Mr. Dunbar D. Scott's Paper on Their Evolution, and Its Discussion. Benjamin Smith Lyman. Ill. 17400 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39230 D.

Remarks on Mine-Surveying Instruments, with Special Reference to Mr. Dunbar D. Scott's Paper on Their Evolution, and Its Discussion. H. D. Hoskold. Ill. 7600 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39223 D.

Surveying.

Controlling a Topographical Survey. William C. Bunnel. A discussion of methods, describing in detail the method recommended and illustrating by an actual case. 3000 w. Eng News—Feb. 14, 1901. No. 39250.

Stadia Surveys for Railway Location. H. P. Boardman. On the advantages of the Stadia method as applied to railway location, and its economy. 2700 w. Eng News—Feb. 21, 1901. No. 39384.

Topography.

The Topographic Mapping of the United States by the U. S. Geological Survey. H. M. Wilson. Gives the early history of the work, showing its utility, and describing methods and cost in present article. 2700 w. Eng News—Feb. 7, 1901. No. 39203.

MUNICIPAL.

Garbage Disposal.

A New Garbage Furnace at Atlanta, Ga. Describes a Lester furnace which has

been in operation about one year, and has given satisfaction. 1200 w. Eng News—Feb. 7, 1901. No. 39206.

Garbage Disposal at Indianapolis, Ind. Gives an outline of the history of garbage disposal in this city, and describes the present reduction system. 1600 w. Eng News—Jan. 31, 1901. No. 39094.

Some Financial, Political and Sanitary Phases of Garbage Disposal. A brief description of a garbage furnace to be tested at one of the electric lighting stations in Chicago, with editorial discussion of various phases of the subject. 2400 w. Eng News—Feb. 14, 1901. No. 39259.

Havana.

Engineering Work in the City of Havana. Engravings showing changes in sanitary conditions, with abstract of report of Gen. Ludlow, giving details of interest. 2500 w. Eng News—Feb. 7, 1901. No. 39202.

Pavements.

The Cost of Asphalt Pavements. F. V. E. Bardol. A table giving itemized cost of base, binder and wearing surface of asphalt pavements in 1900 in 44 cities, with a reduction of the figures to a uniform basis for comparison. 900 w. Eng Rec—Feb. 23, 1901. No. 39390.

Refuse Destructor.

Dust Destruction and Electric Lighting at Fulham. An illustrated account of a combined refuse destructor, electricity supply and disinfector in the Borough of Fulham, England. 5000 w. Lightning—Feb. 14, 1901. No. 39508 A.

Sanitation.

The Civil Engineer as a Guardian of the Public Health. J. B. Johnson. Reprint from Jour. Assn. of Engng. Socs. Concerning the duty of civil engineers to lead public sentiment, and secure sanitary conditions in cities and towns, such as the securing of clean streets, pure water, prompt removal and destruction of refuse, etc. 5300 w. Wis Engr—Jan., 1901. No. 39307 D.

Sewage Disposal.

The Ohio State Board of Health on Septic Sewage Disposal. A review of a report refusing permission to Columbus to dispose of its sewage by septic treatment without subsequent filtration. 2100 w. Eng Rec—Feb. 2, 1901. No. 39130.

The Septic Tank Experiments at Pawtucket. Describes experiments covering 10 months and dealing with a very strong sewage. 1800 w. Eng Rec—Feb. 16, 1901. No. 39315.

Sewers.

Cleaning a Large Brick Sewer in Hartford, Conn. Frederick L. Ford. Describes the methods and gives the cost of cleaning 9,300 ft. of 3 to 6 ft. sewers. 1000 w. Eng Rec—Feb. 16, 1901. No. 39318.

New System of Sewer Ventilation. Illustrates and describes a system which claims not only to give continuous and efficient ventilation to any class of sewer, but to remove all obnoxious gases, and to prevent any bacteria being taken into the air. 1300 w. Engr, Lond—Feb. 8, 1901. No. 39375 A.

The Computation of the Cost of Pipe Sewers by Formulæ. W. G. Kirchoffer. Demonstration showing that the average cost of pipe sewers varies as the square of the depth of the trench in which it is laid. 3000 w. Wis Engr—Jan., 1901. No. 39312 D.

WATER SUPPLY.

Filtration.

Selecting a System for Filtration of Water. Floyd Davis. Discusses efficiency, original cost and operating expenses. 1000 w. Munic Engng—Feb., 1901. No. 39-119 C.

The Experimental Water Filters at New Orleans. Illustrated description of an inexpensive station for testing various water purification processes involving sedimentation and filtration with or without coagulation. 600 w. Eng Rec—Feb. 9, 1901. No. 39233.

Iron Removal.

Removal of Iron From the Water Supply of Superior, Wis. R. D. Chase. History of the water supply is given, with illustrated description of the plant. Gives details of the filter beds, clear water reservoir, aerator, etc. 4000 w. Eng News—Feb. 21, 1901. No. 39387.

Paris.

Supply of Water From Loing and Lunain to Paris (Adduction des Eaux du Loing et du Lunain). F. J. Feugères. Description of additional supplies of potable water to Paris with profiles of route, and illustrations of aqueduct and siphons. 3000 w. 1 plate. Géne Civil—Jan. 19, 1901. No. 39400 D.

Pollution.

Proposed Water Pollution Legislation in Indiana. A discussion of two bills before the Legislature aiming to give the State Board of Health a large measure of control over water pollution. 1000 w. Eng News—Feb. 14, 1901. No. 39260.

Purification.

Plant for Investigating the Purification of Mississippi River Water at New Orleans. Illustrated description of recently installed plant. 600 w. Eng News—Feb. 7, 1901. No. 39205.

Water Purification in Washington. Gives the reasons of R. Hering, G. W. Fuller and A. Hazen for recommending slow filters, sedimentation basins and the

occasional use of a coagulant for purifying the Potomac River water. 800 w. Eng Rec—Feb. 23, 1901. No. 39388.

Reservoirs.

Reservoir Dams. A discussion of the disputed features in the design of high dams, both earth and masonry, referring particularly to hydrostatic pressures within the mass of the dam. 1500 w. Eng Rec—Feb. 9, 1901. No. 39231.

Vienna.

The Emperor Francis Joseph Water Supply (Der Kaiser Franz Josefs-Hochquellenleitung). F. Berger. A description of the new sources of potable water to be provided for Vienna, with an account of the preliminary studies prior to the construction of the works. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 18, 1901. No. 39442 B.

Water-Works.

The Arad Water Works and Fischer Plate Filters. Illustrated description of a method of sand filtration in a town in Hungary, and which has been adopted to a considerable extent on the Continent. 1200 w. Engng—Feb. 15, 1001. No. 39517 A.

Tokyo City Water Works. Brief illustrated description of the new system of water supply, which is based on the most approved practice. 1100 w. Engng—Feb. 1, 1901. No. 39286 A.

MISCELLANY.

Nature's Stores.

The Coming Exhaustion of Nature's Stores. Editorial on the economics and industrial changes to be anticipated in the coming century, reviewing some of the points needing the careful study of the engineer. 3300 w. Eng News—Jan. 31, 1901. No. 39093.

Nineteenth Century.

Nineteenth Century Engineering: Its Evolution, and Something of Its Beginnings in America. Edgar Marburg. An interesting review showing the progress and the benefits due to science. 7500 w. Pro Engs' Club of Phila—Feb., 1901. No. 39237 D.

Siberia.

Engineering Opportunities in Central and Southwestern Asia. A. H. Ford. Mr. Ford's second paper deals with the various engineering developments, railway, manufacturing, and mining, of Russian Asia, calling attention to the opening for Anglo-Saxon enterprise. 3500 w. Engineering Magazine—March, 1901. No. 39476 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Bank Telegraph.

The Forerunner of the Telephone. Edward A. Calahan. Illustrated description of instruments and the system for a bank and private line used before the invention of the telephone. 1500 w. Elec Wld & Engr—Feb. 23, 1901. No. 39534.

Cables.

Methods of Locating Faults in Underground Electric Cables. H. W. Fisher. Describes the methods used in daily practice, and also original methods which the writer has found of service. 11200 w. Pro Engs' Soc of W. Penna.—Dec., 1900. No. 39306 D.

Multiplex.

A Method for Multiplex Wire and Space Telegraphy (Eine Methode für Mehrfache Draht und Funkentelegraphic). Anders Bull. A paper before the Electrotechnical Society, suggesting a system of variable wave impulses, applicable to telegraphy with or without wires. 3000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39462 B.

An Improved Simple Method of Multiplex Telegraphy (Vorschlag zu Einer Neuen Einfachen Methode der Vielfachtelegraphie). J. W. Giltay. The system is based on the use of alternating currents of different periodicity. 2000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39461 B.

Space Telegraphy.

Application of a Telephone Receiver to Wireless Telegraphy (Application Directe d'un Recepteur Telephonique à la Telegraphie sans Fil). MM. Popoff and Ducretet. Showing how the distance over which space telegraphy can be operated is materially increased by the use of telephone receivers. 1000 w. Comptes Rendus—Dec. 31, 1900. No. 39420 D.

A Tuning System for Wireless Telegraphy. Anders Bull. An explanation of the principle ot a system invented by the writer, for preventing the interception of messages by stations for which they were not intended. 2200 w. Elect'n, Lond—Feb. 8, 1901. No. 39360 A.

Multiple Spark Telegraphy. Editorial review of Prof. Slaby's lecture upon the practicability of using wireless telegraphy without interference of messages. 2500 w. Engng—Feb. 8, 1901. No. 39369 A.

Steering Torpedoes by Wireless Telegraphy. An illustrated account of the work of an English electrician, Cecil Varicas, and successful experiments in

steering submarine torpedoes. 1600 w. Sci Am—Feb. 16, 1901. No. 39294.

The Action of Apparatus for Wave Telegraphy (Ueber die Richtfähigkeit der Wellentelegraphischen Apparate). Dr. R. Blockmann. An examination of the propagation of electrical waves, and the manner in which they may be employed to transmit messages. 2500 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39458 B.

Stock Tickers.

The Evolution of the Stock Ticker. Edward A. Calahan. An interesting account of the invention and development of this apparatus. 2800 w. Elec Wld & Engr—Feb. 9, 1901. No. 39264.

Telephone Lines.

A Few Notes on the Construction of Telephone Lines in Norway. Illustrated description of some peculiarities in construction, seen by the writer. 1800 w. Elec Rev, Lond—Feb. 8, 1901. No. 39376 A.

Telephone Exchange.

The Automatic Telephone Exchange at New Bedford, Mass. Alton D. Adams. Explains the general principles of the system, and gives an illustrated detailed description of the apparatus and station. 2500 w. Elec Wld & Engr—Feb. 9, 1901. No. 39262.

The Independent Telephone Exchange at Rochester, N. Y. Illustrated description of a modern equipped exchange. 1000 w. Elec Wld & Engr—Feb. 23, 1901. No. 39531.

Telephones.

The Dynamo in Recent Telephone Practice. D. M. Bliss. An illustrated description of apparatus now considered standard for supplying exchange systems, the arrangement of circuits, etc. The dynamo is especially considered. 2500 w. Elec Wld & Engr—Feb. 23, 1901. No. 39532.

The Telephone Auto-Commutator. An illustrated explanation of the principle of a system recently installed in France for calling subscribers without the aid of the central office. 1100 w. Sci Am—Feb. 9, 1901. No. 39208.

The Telephone Company of Guatemala. Brief illustrated description of the system. 700 w. Elec Rev, N. Y.—Feb. 16, 1901. No. 39329.

The Valuation and Taxation of Telephone Companies in Michigan. W. J. Rice. An explanation of the work of the Michigan Board of State Tax Commission; the results reached as a basis for the appraisal of telephone properties, and matters related. 3700 w. Elec Wld & Engr—Feb. 2, 1901. No. 39143.

DISTRIBUTION.

Alternating Currents.

Alternating-Current Development in Austria. Frank C. Perkins. An illustrated account of some installations of interest. 1500 w. W Elect'n—Feb. 23, 1901. No. 39505.

Capacity in Alternate-Current Working. An interesting letter from Dr. Maurice de Hoor, criticizing some statements in W. M. Mordey's paper. 1800 w. Elect'n, Lond—Feb. 8, 1901. No. 39364 A.

Circuit Breakers.

Some Recent Tests of Magnetic Circuit Breakers. Hugh A. Brown. Investigations which formed a part of a graduation thesis at Columbia University, the object being to determine how accurately circuit breakers act, and their working. 1500 w. Elec Wld & Engr—Feb. 9, 1901. No. 39263.

Cut-Out.

A New Automatic Cut-Out. H. Müller. Illustrated description of a new design. 1000 w. Elect'n, Lond—Feb. 8, 1901. No. 39363 A.

Three-Phase.

The Development of Three-Phase Working in the Twentieth Century. Val. A. Fynn. Considers briefly the items which make up a three-phase transmission and distribution, the improvements desirable, and those that may be expected, and cases where the application of this system would seem consistent with economy. 3500 w. Elec Rev, Lond—Feb. 1, 1901. No. 39275 A.

ELECTRO-CHEMISTRY.

Accumulators.

See Mechanical Engineering, Automobilism.

Autoxidation.

Autoxidation and Its Connection with the Theory of Ions (Ueber die Autoxydation und Ihren Zusammenhang mit der Theorie der Ionen). F. Haber. An examination of the theory of ions in connection with the electrochemical action of galvanic elements. 3000 w. Zeitschr f Electrochemie—Jan. 31, 1901. No. 39466 G.

Reflectors.

The Cowper-Coles Electrolytic Process for the Manufacture of Parabolic Reflectors. An illustrated account of an ingenious process. 2800 w. Elect'n, Lond—Feb. 8, 1901. No. 39362 A.

ELECTRO-PHYSICS.

Accumulators.

The Resistance of Lead Plate Accumulators (Ueber den Widerstand von Bleiakkumulatoren). F. Dolezalek and R. Gahl. With diagrams giving the results of numerous measurements, and showing the distribution of resistance between the two electrodes. Two articles, 3500 w. Zeitschr

f Elektrochemie—Jan. 24, 31, 1901. No. 39465 each G.

Apparent Hysteresis.

Apparent Hysteresis in Torsional Magnetostriction, and Its Relation to Viscosity. C. Barus. Experimental investigations with results. 4200 w. Am Jour of Sci—Feb., 1901. No. 39187 D.

Luminescence.

The Luminescence of a Rarified Gas Around Metallic Wires (Luminescence d'un Gaz Raréfie autour des Fils Metalliques). J. Borgman. A study of the luminous effects produced when a wire connected to one pole of an induction coil passes through a rarefied gas. 1200 w. Comptes Rendus—Dec. 24, 1900. No. 39419 D.

GENERATING STATIONS.

Alternators.

The Three Phase Alternators of the Metropolitan Street Railway Company of New York City. Harris J. Ryan. A study of the design and performance of those alternators, which are typical of the latest American practice. Ill. 3800 w. Sib Jour of Engng—Feb., 1901. No. 39529 C.

Austria.

The Abbazia Electric Station (Des Elektrizitätswerk Abbazia). A brief illustrated description of the steam power electric-lighting station at Abbazia in the Austrian Riviera. 1200 w. Zeitschr d Vet Deutscher Ing—Jan. 26, 1901. No. 39434 D.

Converters.

Synchronous Converters. W. E. Goldsborough. Read before the Northwestern Elec. Assn. Considers this useful electrical device, explaining the theory of its working, and its management. 4500 w. Elec Rev, N. Y.—Feb. 2, 1901. No. 39140.

Generating Set.

Generating Set of 1,200 Kilowatts (Groupe Electrogene de 1,200 Kilowatt). Detailed description of horizontal compound engine of 1,000 h. p. by the Brünn Machine Works and 1,200 k. w. three-phase generator by Ganz & Co., exhibited at Paris. 2500 w. 1 plate—Génie Civil—Jan. 26, 1901. No. 39403 D.

Hydraulic Plant.

The Water-Power Plant at Massena, N. Y.; St. Lawrence Power Co. Illustrated description of the canal, dam and power-house, electrical equipment, etc. Eng News—Feb. 21, 1901. No. 39383.

Isolated Plants.

Cost Determination in Isolated Electric Plants. P. R. Moses. Discussing the methods of recording and classifying cost data so as to enable intelligent conclusions to be deduced. 3000 w. Engineering Magazine—March, 1901. No. 39477 B.

Northwich, England.

Northwich Electricity Works. Illustrated detailed description of an installation having interesting features. 2800 w. Elec Rev, Lond—Feb. 1, 1901. No. 39277 A.

Parallel Running.

Relation of Characteristic Curves of Direct-Current Dynamos to Parallel Operation. Alton D. Adams. Shows curves for series, shunt, evenly compounded and over-compounded dynamos, discussing the results, indicated. 900 w. Am Elect'n—Feb., 1901. No. 39186.

Running Continuous-Current Electric Generators in Parallel. Explains methods of connection, and discusses in detail the distribution of the current. Ill. 2500 w. Col Guard—Feb. 8, 1901. No. 39365 A.

Prices.

The Determination of the Price of Current for Electric-Supply Stations (Die Bemessung des Strompreises bei Elektrizitätswerken). K. Wilkens. An examination of daily and monthly diagrams for the purpose of determining an equitable basis for charges; the results are compared for a number of stations. 3000 w. Elektrotech Zeitschr—Feb. 7, 1901. No. 39463 B.

Rates.

The Rate Question. H. L. Doherty. A discussion of the relative value of the meter and the flat rate systems, and advocating the charging for electric power by a combination of fixed and variable charges. 1800 w. Am Gas Lgt Jour—Feb. 4, 1901. No. 39136.

Switchboards.

Switchboard Construction. John H. Hertner. Discusses points to be considered in switchboards of various sizes and purposes, the materials used, etc. Ill. 2300 w. Engr, U. S. A.—Feb. 1, 1901. No. 39197.

Transformers.

The Design of Transformers. W. B. Woodhouse. Explains the method of design, the two types of modern transformers, and the advantages of each, etc. 1700 w. Elect'n, Lond—Feb. 15, 1901. Serial. 1st part. No. 39514 A.

Transformer Incidents. Thomas W. Varley. Gives some interesting incidents in the use of transformers, explaining the causes. 800 w. Elec Wld & Engr—Feb. 23, 1901. No. 39533.

Wigan, England.

Wigan Electricity Works. Illustrated description of the works and their equipment. 6600 w. Elec Engr, Lond—Feb. 1, 1901. No. 39215 A.

LIGHTING.

Address.

Electrical Illumination at the Beginning

of the Twentieth Century. Brief of a lecture by Dr. Louis Bell given before the N. Y. Elec. Soc. 5600 w. Elec Wld & Engr—Feb. 9, 1901. No. 39265.

Arc Lamps.

Arc-Lamp Standardization. Harold Almert. Read before the Chicago Elec. Assn. Discusses the difficulties in arc-light photometry, and the unsuitability of the candle as a standard for practical use. 2300 w. W Elect'n—Feb. 2, 1901. No. 39152.

The Economic Radius of Arc-Lamp Service from Constant-Pressure Dynamos. Alton D. Adams. Discusses the operation of arcs directly from constant pressure circuits, the advantages and disadvantages. 3500 w. Elec Rev, N. Y.—Feb. 23, 1901. No. 39380.

Chicago.

Municipal Electric Lighting in Chicago. Edward B. Ellicott. Report by the city electrician, of 13 years' operation of municipal electric stations. 1600 w. Eng Rec—Feb. 23, 1901. No. 39391.

Incandescent Lamps.

The Efficiency of the Incandescent Lamp. Ed C. de Segundo. A discussion of this subject, quoting from paper by Arthur J. Rowland, read before the Franklin Inst. 1000 w. Elec Rev, Lond—Feb. 1, 1901. Serial. 1st part. No. 39276 A.

Legislation.

Penalties Under the Electric Lighting Acts. A review of points concerning the rights of consumers and "undertakers" in Great Britain. 2200 w. Engng—Feb. 1, 1901. No. 39289 A.

Switchboards.

Switchboards for Electric Lighting. J. H. Hertner. Brief review of the development and an illustrated description of the connections and arrangements of the modern switchboard. 2000 w. Engr, U. S. A.—Feb. 15, 1901. No. 39350.

MEASUREMENT.

Errors.

Errors in Magnetic Measurements Caused by Oxidation of Iron (Ueber die durch Oxydschichten des Eisens Verursachten Fehler Magnetischer Messungen). H. Kamps. Discussing and computing the influence of films of oxide of various thicknesses. 5000 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39456 B.

Galvanometers.

The Hartmann and Braun Galvanometers (Les Galvanometers Hartmann et Braun). J. A. Montpellier. With illustrations of fine reflecting galvanometers exhiibted at Paris. 1800 w. Electricien—Jan. 19, 1901. No. 39467 B.

Insulation.

Testing the Insulation Resistance of a Conductor (Eine Einfache Methode zur Prüfung des Isolationwiderstandes von Leitungsmaterialen). Dr. J. Rabinowicz. The insulated conductor is immersed in water, the latter being in a circuit into which a condenser and galvanometer may be successively thrown. 1000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39460 B.

Meters.

Small Meters for Electric Energy (Petits Compteurs d'Energie Electrique). Illustrated description of the meters for continuous and alternating currents, exhibited by the Allgemeine Elektrizitäts Gesellschaft at Paris. 2000 w. Electricien—Feb. 9, 1901. No. 39469 B.

Meter Testing.

The Method of Testing Alternating-Current Meters at the Reichsanstalt (Ueber Einrichtungen und Methoden zur Prüfung von Wechselstromzählern in der Physikalisch-Technischen Reichsanstalt). E. Orlich. A detailed account of the equipment of the testing department and the routine of actual work. 5000 w. Elektrotech Zeitschr—Jan. 31, 1901. No. 39459 B.

Observatory.

New Magnetic Observatory of the United States Government. An illustrated description of the buildings at Cheltenham, Md., and their equipment. 2200 w. W Elect'n—Feb. 9, 1901. No. 39296.

Testing.

Portable Cable-Testing Apparatus (Transportable Apparatenzusammenstellung für Kabeluntersuchungen). Prof. M. T. Edelmann. Describing and illustrating a convenient combination for testing insulation, capacity and resistance. 1200 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39457 B.

POWER APPLICATIONS.

Canal Traction.

The Development of Electric Traction on Canals. A summary of the work which has been done in the United States, and brief notice of recent work in Europe. 3500 w. Elec Wld & Engr—Feb. 2, 1901. No. 39142.

Fan Motors.

Electric Fans for 1901. Describes and illustrates various styles of direct and alternating-current fan motors. 7000 w. Elec Rev, N. Y.—Feb. 9, 1901. No. 39250.

The History and Development of the Electric Fan Motor. F. V. Henshaw. Reviews the history of this American invention, giving illustrations of various designs. 3800 w. Elec Rev, N. Y.—Feb. 9, 1901. No. 39249.

Fans.

Electric Fans in the Export Trade.

Arthur Stanley Riggs. A discussion of the present standing and future outlook. 2200 w. Elec Rev, N. Y.—Feb. 9, 1901. No. 39251.

Induction Motors.

Induction Motors in a Tobacco Factory. F. E. Bausch. Illustrated description of the power plant of the M. C. Wetmore Tobacco Co., of St. Louis, Mo., with a capacity of 100,000 lbs. of tobacco daily. 1000 w. Am Elect'n—Feb., 1901. No. 39184.

Mining Plant.

Electricity in Mining. Lawrence Birks. The first of a series of articles on the advantages of electrical installations. The present article deals principally with its use as an illuminant. Ill. 1600 w. Aust Min Stand—Jan. 10, 1901. Serial. 1st part. No. 39359 B.

The Electrical Installation at Ackton Hall Colliery. Illustrated description of a large light and power plant in England. 1800 w. Col Guard—Jan. 25, 1901. No. 39166 A.

The Electric Plant at the Carmaux Mines (Installations Electriques des Mines de Carmaux). A. Bainville. The gas from coke furnaces is used to supply steam for 1,400 h. p. generating sets. Plans for the generators, switch boards and distribution are given. 2000 w. Electricien—Jan. 26, 1901. No. 39468 B.

The Utilization of Electrical Machinery in Coal Mining. W. C. Mountain. On the necessity of introducing electrical machinery, and its application. Ill. 3000 w. Elec Rev, Lond—Feb. 8, 1901. No. 39378 A.

Printing Office.

The New Plant of the Curtis Publishing Co. Charles Henry Davis and John S. Griggs, Jr. Illustrated description of a large printing establishment with electric power transmission throughout. 4400 w. Eng Rec—Feb. 23, 1901. Serial. 1st part. No. 39389.

Review.

Electrical Apparatus. A long illustrated review of the development of the electric motor from the earliest devices down to the present time. 1500 w. Engr, U. S. A. —Jan. 15, 1901. No. 39080.

TRANSMISSION.

California.

Transmission System of the Bay Counties Power Company, California. Describes a large undertaking designed for 60,000 volts line pressure, supplying power to the mining districts in Yuba and Nevada Co.'s, and to Oakland. 1200 w. Elec Wld & Engr—Feb. 16, 1901. No. 39326.

South Africa.

Experience with Electric Power Transmission in South Africa. Abstract of a paper by H. J. S. Heather, presented to the Institution of Civil Engineers, describing troubles caused by lightning, in electric transmission plants in South Africa, and the growth of a direct current system, and its final transformation to an alternating plant. 2200 w. Eng Rec—Feb. 9, 1901. No. 39236.

Sumatra.

A Power Transmission Plant in Sumatra. Illustrates and describes a water-driven three-phase power-transmission plant installed at the Redjang-Lebong gold mine. 2000 w. Elect'n, Lond—Feb. 8, 1901. No. 39361 A.

MISCELLANY.

Education.

Self-Instruction in Electrical Engineering. W. H. Radcliffe. Suggestions and lists of helpful literature for the aid of those wishing to study this subject. 1300 w. Elec Rev, N. Y.—Feb. 16, 1901. No. 39330.

Trade Education of Central-Station Employees. D. C. Jackson, F. A. Copeland and H. L. Doherty. Abstract of a report of a committee of the N.-W. Elec. Assn., appointed to consider the advisability of encouraging employees to enroll themselves in correspondence schools. 6000 w. W Elect'n—Jan. 26, 1901. No. 39073.

Obstruction.

Official Obstruction of Electric Progress. J. A. Fleming. Reviews briefly the great electrical inventions, noting the nationality of the inventors, and discusses the reasons why electrical inventions have moved so slowly in Great Britain, and the reforms needed. 6200 w. Nineteenth Cent—Feb., 1901. No. 39333 D.

GAS ENGINEERING

American Methods.

Business Sketches in America. E. W. T. Richmond. The first of a series of articles on points of interest to the gas industry. 5800 w. Jour Gas Lgt—Jan. 29, 1901. Serial. 1st part. No. 39273 A.

Gas Matters in the United States. An explanation of methods of business in gas undertakings, a description of American types of gas-engines, cooking and heating practice, etc. 7500 w. Jour Gas Lgt—Feb. 5, 1901. No. 39297 A.

Furnace Gas.

The Utilisation of Gas from Blast Furnaces and Coke Ovens (Utilisation des Gas de Hauts Fourneaux et de Fours à

Coke). E. Deschamps. The first installment of a serial discussing the subject of the utilisation of furnace gases in gas engines. Serial. Part I. 4000 w. Rev de Mécanique—Jan., 1901. No. 39422 H.

Gas Fitting.

Practical Gas Fitting. Henry Vardiman, in the *Engineering Review*. Suggestions regarding the places for and kind of fixtures; the sizes and lengths of pipes for different kinds of gas, etc. 1800 w. Pro Age—Feb. 15, 1901. No. 39344.

Gas Heating.

The Alleged Dryness of Air in Rooms Warmed by Gas-Fires. Thomas Fletcher. A report of careful experiments made in such a form that they can be repeated and verified. 1500 w. Jour of Gas Lgt—Feb. 12, 1901. No. 39507 A.

Holders.

Steel Gas Holders. W. A. Baehr. A topical discussion pointing out some of the problems connected with the foundation, the tank, the holder and the guide framing. 1500 w. Wis Engr—Jan., 1901. No. 39310 D.

Instruction.

Technical Instruction in Gas-Making in Germany. Details of an important scheme for the training of foremen, of managers, and of lighting engineers. 3000 w. Gas Wld—Feb. 2, 1901. No. 39274 A.

"Mond" Gas.

The Manufacture of "Mond" Gas in Central Stations. A. Rollason. Read before the South Staffordshire Ir. and Steel Inst. Illustrates and describes the Mond gas plant, giving much information concerning its operation, and a statement of the advantages. 2200 w. Col Guard—Feb. 15, 1901. No. 39524 A.

Street Lighting.

The Lighting of City Streets. E. C. Jones. Read before the Convention of the League of California Municipalities. Principally descriptive of the Welsbach burners used in San Francisco, with comparative cost of different lights. 2400 w. Jour of Elec—Dec., 1900. No. 39145.

Water Gas.

Regulating the Air Supply to Burners Consuming Mixed Coal and Water Gas. H. Leicester Greville. Remarks on the suitable regulation, and the faults due to the appliances rather than to the gas. 2000 w. Jour Gas Lgt—Jan. 22, 1901. No. 39107 A.

Water-Gas Generators (Gazogènes pour Gas à l'Eau). J. Deschamps. An examination of the Dellwik-Fleischer and the Strache processes, with diagrams showing the output and the composition of product. 2000 w. Génie Civil—Jan. 26, 1901. No. 39404 D.

MARINE AND NAVAL ENGINEERING

Armour.

The Disposition of British Battleship Armour. Editorial on the recently launched new class battleships, which are remarkable for their high speed, and for the greater distribution of their broadside armour. 2200 w. Engng—Feb. 15, 1901. No. 39518 A.

Balancing.

The Balanced and Unbalanced Engines of Torpedo Boat S. 42 (Vergleich Zwischen der Ausgeglichen und der Unausgeglichinen Maschine des Torpedobootes S. 42). Hans Mohr. A study of the problem of balancing four-crank engines, taking into account the finite length of the connecting rod. Two articles. 5000 w. Schiffbau—Jan. 8, 23, 1901. No. 39446 each D.

Boilers.

The Constructive Development of the Dürr Boiler in the German Navy (Die Konstruktive Entwicklung der Dürr-Kessel in der Deutschen Kriegsmarine). An account of tests of the Dürr water-tube boiler, and illustrations of various installations in vessels of the German navy. Serial. Part I. 4000 w. 2 plates. Schiffabu—Feb. 8, 1901. No. 39448 D.

Coaling.

The Coaling Stations of the United States Navy. Waldon Fawcett. Illustrates and describes the station at New London, Conn., its equipment, etc. Also gives information of other stations to be similarly fitted. 1200 w. Am Mfr—Feb., 1901. No. 39150.

Cruisers.

New Russian First-Rate Protected Cruisers—Improved Bogatyr Type. An illustrated description of a vessel accepted as the standard for all future big protected cruisers in Russia. 1200 w. Engr, Lond—Feb. 8, 1901. No. 39374 A.

Education.

The Education of a Shipbuilder. Prof. J. H. Biles. From a lecture delivered before the Glasgow and West of Scotland Technical College Scientific Society. 2000 w. Naut Gaz—Feb. 7, 1901. No. 39219.

Ferryboat.

Magnificent Ferryboat. Illustration and

description of the new screw ferryboat "Chicago," for use in New York waters by the Pennsylvania Co. 2500 w. Naut Gaz—Feb. 14, 1901. No. 39341.

Freighters.

Large Ocean Freighters. Illustrated description of two new vessels under construction for the Boston Steamship Co. 1200 w. Naut Gaz—Feb. 7, 1901. No. 39216.

Splendid Lake Freighter. Illustration and brief description of the new steel steamship "Wilkes-Barre," built at the Union Dry Dock Company's plant, Buffalo. 700 w. Naut Gaz—Feb. 7, 1901. No. 39218.

Japan.

Shipping and Shipbuilding in Japan. Condensed information from recent publication by the Mercantile Marine Bureau. 800 w. Engng—Feb. 1, 1901. No. 39290 A.

Jet Propeller.

Centrifugal Hydraulic Propellers for Boats (Propulseur Centrifuge Hydraulique pour Bateaux). A. Dumas. Describing a system of jet propulsion recently tried with some success on the Seine. 1800 w. Génie Civil—Feb. 2, 1901. No. 39408 D.

Lake Commerce.

Commerce of Lake Superior. Information from an interesting report of government officials in charge of the St. Mary's Falls canal. 2700 w. Marine Rev—Feb. 21, 1901. No. 39398.

Lake Superior.

Early Days on Lake Superior. An account of conditions which existed before the opening of the Sault Ste. Marie canal. 4800 w. Marine Rev—Feb. 21, 1901. No. 39399.

Marine Engines.

Machinery for the New U. S. Battleships and Armored Cruisers. Illustrated description of the engines, representing very large units and all modern improvements. 1500 w. Marine Engng—Feb., 1901. No. 39200 C.

The Marine Engine. An illustrated review of the history of steam propulsion for vessels. 4800 w. Engr, U. S. A.—Jan. 15, 1901. No. 39076.

Maritime Commerce.

A Brief Sketch of the Origin and Development of the World's Shipping. Lawrence Irwell. An interesting review, giving some idea of the immense carrying trade, and the part taken by the different countries of the world. 2200 w. Marine Engng—Feb., 1901. No. 39199 C.

Merchant Marine.

The World's Merchant Marine and Shipbuilding. Facts from an article published in the *Frankfurter Zeitung* are discussed. 500 w. U. S. Cons Repts, No. 967. Feb. 20, 1901. No. 39348 D.

Naval Architecture.

Construction of Torpedo Boats and Destroyers. George Herbert Wilson. The first of a series of about twenty-five articles, containing subjects of interest to naval architects, shipbuilders, etc., and will apply to yachts and like craft as well as to the subject given. Ill. 3000 w. Marine Rev—Feb. 14, 1901. Serial. 1st part. No. 39334.

Pacific Liners.

The New Pacific Mail Liners. Illustration, with brief description of large vessels, nearing completion at the Newport News shipyard. 900 w. Naut Gaz—Feb. 7, 1901. No. 39221.

Pinnace.

Steam Pinnace (Dampfpinasse). Detailed description of steam pinnace built for the German navy, with sections of hull and machinery, and indicator diagrams taken during trial run. 1200 w. Schiffbau—Jan. 23, 1901. No. 39447 D.

Report.

Naval Lessons from America. Editorial on the report of Admiral Melville, Chief of the United States Bureau of Steam Engineering. 3000 w. Engng—Feb. 8, 1901. No. 39368 A.

Rules.

New Steamboat Rules and Regulations. Full text of the amended rules prepared under the direction of James N. Dumont. 2200 w. Naut Gaz—Feb. 21, 1901. No. 39527.

Shipbuilding.

Eastern Ship Building Co., New London, Conn. Illustrated description of interesting features of vessels undergoing construction, and of the company's plant. 2200 w. Marine Rev—Feb. 7, 1901. No. 39245.

Harlan & Hollingsworth Co., Wilmington, Del. Illustrates and describes some of the vessels constructed by this company. 2200 w. Marine Rev—Feb. 7, 1901. No. 39246.

Newport News Ship Building and Dry Dock Co. Illustrated description of improvements at this plant, and some of the vessels in process of construction. 2700 w. Marine Rev—Feb. 7, 1901. No. 39248.

Shipbuilding and Marine Engineering During 1900. A review of this industry, the present article being confined to the volume of work accomplished during the last year in the United Kingdom. 2700 w. Engr, Lond—Jan. 25, 1901. Serial. 1st part. No. 39169 A.

Union Iron Works, San Francisco. Gives an illustrated general description of

the shops, ways and slips; vessels under construction, and of the novel features introduced. 5000 w. Marine Rev—Feb. 7, 1901. No. 39244.

Shipping Bill.

Senator Depew on the Shipping Bill. Reports a speech before the U. S. Senate indorsing the bill. 4000 w. Marine Rev—Jan. 31, 1901. No. 39137.

Ship Subsidies.

Substitutes for Ship Subsidies: A Reply. Alexander R. Smith. Answering the arguments set forth in paper by Louis Windmüller in the Jan. issue of the N. Am. Rev. 2000 w. N Am Rev—Feb., 1901. No. 39135 D.

Signaling.

Submarine Signaling. Arthur J. Mundy. An illustrated account of a device due to the writer and Prof. Elisha Gray, which sends a signal twelve miles. 1200 w. Sci Am—Feb. 2, 1901. No. 39099.

Steamers.

Peculiarities of Lake Steamers. Theodore Lucas. Description, with illustrations of characteristics of construction, suggesting improvements and considering the fitness of this type for coast service. 1400 w. Marine Rev—Jan. 31, 1901. No. 39138.

River and Bay Steamers of the Atlantic Coast. Theodore Lucas. The first of a series of articles to treat on various important subjects of interest to shipbuilders, owners and students of naval architecture. Ill. 1500 w. Naut Gaz—Feb. 7, 1901. No. 39217.

Steamship "Grecian" of the Boston and Philadelphia S. S. Co.'s Fleet. Illustrated description of a modern coast line vessel. 1500 w. Marine Engng—Feb., 1901. No. 39201 C.

Submarine.

Early Submarine Warfare. An account of early attempts at building submarine vessels for war purposes. 2000 w. Engr, Lond—Feb. 1, 1901. No. 39281 A.

Submarine Boats. Discusses the attitude of the French Government to the subject of submarine navigation, and gives an illustrated description of the Nordenfeldt submarine boat for Turkey, built in 1887. 3300 w. Engr, Lond—Jan. 25, 1901. Serial. 1st part. No. 39170 A.

The American Submarine Boats. Waldon Fawcett. Information concerning the boats now building and the trials to be made with them. Ill. 1500 w. Am Mfr —Feb. 14, 1901. No. 39343.

Tugboat.

Ocean Tugboat. Description of the "Cuba," now under construction at the shipyard of the Bath Iron Works. 1200 w. Naut Gaz—Feb. 7, 1901. No. 39220.

Wrecking.

To Raise the "Maine." A brief account of the methods by which the successful contractors propose to raise this vessel, and also the "Alfonso XII." 600 w. Ir Age—Feb. 14, 1901. No. 39252.

Yachts.

Elegant Steam Yacht. Illustrated description and plans of the new craft for Leonard Lewishon under Construction at Morris Heights, N. Y. 700 w. Naut Gaz —Jan. 31, 1901. No. 39106.

The Hamburg-American Yacht, "Prinzessin Victoria Luise." Illustrated description of a vessel specially designed for pleasure tours. 1100 w. Sci Am—Feb. 9, 1901. No. 39209.

Yacht Construction During 1900. Illustrates and describes some of the yachts built at Morris Heights, N. Y. 1200 w. Marine Rev—Feb. 7, 1901. No. 39247.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

The Weight of an Electric Accumulator for the Propulsion of a Vehicle (Recherche du Poids d'Accumulateurs Electriques Nécessaires à la Propulsion d'un Vehicle). D. Dujon. A mathematical investigation, deriving formulas for practical application, with tables. 3000 w. Revue Technique—Jan. 25, 1901. No. 39412 D.

Ball Bearings.

Ball Bearings, Big Wheels, and Other Matters. A discussion of motor car development, comparing the experimental results of Prof. Vernon Boys with the results obtained by calculation by Dr. Luxenberg and drawing conclusions regarding the general aspects. 2500 w. Auto Jour—Feb., 1901. No. 39510 A.

Bicycles.

Motor Bicycles. Reviews some of the peculiar characteristics of the bicycle, and considers the application of a motor, and points of construction. 2300 w. Auto Jour—Feb., 1901. No. 39513 A.

Some Experiences of Motor Bicycles. Joseph Pennell. An account of the writer's experiences in making an extended trip through Europe. General discussion. 10000 w. Jour Soc of Arts—Feb. 8, 1901. No. 39349 A.

Chicago.

New Electric-Vehicle Service Proposed for Chicago. Relating to a proposed service of 'buses and cabs at low rates. Ill. 800 w. W Elect'n—Jan. 26, 1901. No. 39072.

Commercial Vehicles.

Automobiles in Business. R. H. Thurston. On the conditions to be met, the requirements, and principles demanded for success; with a comparison of various kinds of motive power. 3000 w. Horseless Age—Feb. 6, 1901. No. 39192.

Mechanically Driven Wagons for the Transportation of Merchandise. Henri G. Chatain. Classifies the merchandise to be transported, and discusses the motive powers best suited to the work, giving the first place to steam. 1400 w. Horseless Age—Feb. 6, 1901. No. 39194.

Steam Freight Wagons. Discusses the difficulties to be overcome and the requirements, showing that for loads of 1,000 pounds and over, steam is the only power. 1400 w. Horseless Age—Feb. 6, 1901. No. 39193.

The Electric Automobile for Business Purposes. R. A. Fliess. Giving data of actual performance of electric delivery wagons, with numerous tables of mileage, demonstrating the success of electricity for light service. 5600 w. Horseless Age—Feb. 6, 1901. No. 39195.

Compensating Gear.

Compensating Gear for Motor Vehicles—Its History and Development. Sidney Russell. Reviews the earlier methods of driving, the present article bringing the history down to 1830-33. Ill. 3000 w. Auto Jour—Feb., 1901. Serial. 1st part. No. 39511 A.

Design.

The Influence of Climate, Road and Load Conditions on Business Automobile Design. Walter L. Bodman. Considers the difficulties to be met in the manufacture of these vehicles, the cost of the work, etc. 5000 w. Horseless Age—Feb. 6, 1901. No. 39196.

Electric Vehicle.

Holson Two-Wheeled Electric Vehicle. Illustration and brief description of a vehicle consisting of a seat and carriage frame suspended between two large wheels, the electric motors being in the hubs of the wheels. 1200 w. W Elect'n—Feb. 23, 1901. No. 39506.

Exhibition.

The Austrian Automobile Exhibition at Vienna, 1900 (Die Oesterrischische Automobil-Austellung in Wien, 1900). Prof. L. Czischek. A general description, with numerous illustrations, of the various vehicles exhibited. 2000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 1, 1901. No. 39445 B.

Gasoline Vehicles.

Road Repairs Upon Gasoline Vehicles. Albert L. Clough. Suggestions concerning ways of temporarily remedying mishaps. 3200 w. Horseless Age—Feb. 20, 1901. No. 39379.

The Inspection of Gasoline Vehicles. Albert L. Clough. Calls attention to the importance of inspection before starting, giving suggestions of such details as are of special consequence. 3300 w. Horseless Age—Feb. 13, 1901. No. 39292.

Housing.

Winter Use and Housing of Automobiles. Albert L. Clough. Discusses care needed to secure these vehicles from damage from freezing temperatures. 1000 w. Horseless Age—Jan. 30, 1901. No. 39068.

Motor Cars.

Motor Cars in Paris. A discussion of the motor carriage industry, and the development as shown in the character of the exhibits at the annual show organized by the Automobile Club de France in the Grand Palais in Paris. 4000 w. Engr, Lond—Feb. 15, 1901. No. 39521 A.

Proposed Trial.

The 1,200 Miles Trial. Mark Mayhew. Extracts from a paper read before the Automobile Club of Gt. Britain and Ireland. A discussion of where the trial should be held; the legal limit of speed in England, etc. 3000 w. Auto Jour—Feb., 1901. No. 39512 A.

Springs.

Springs for Automobiles. M. C. Krarup. Discusses this subject, considering the rules for the design of springs for railway coaches, and horse-drawn carriages, and the factors to be considered in springs for automobiles. Ill. 2300 w. Horseless Age—Jan. 30, 1901. Serial. 1st part. No. 39067.

HYDRAULICS.

Hydraulic Plant.

The Hydraulic-Electric Works of Saut-Mortier (Usine Hydro-Electrique du Saut-Mortier). J. Claudet. An illustrated description of the plant by which 3,000 h. p. is derived from the river Ain, in the department of the Jura, France. 2000 w. Génie Civil—Feb. 9, 1901. No. 39409 D.

See Electrical Engineering, Generating Stations.

Niagara.

The New Wheelpit of the Niagara Falls Power Company. Illustrated description of a wheelpit 20 x 463 ft. in plan and 180 ft. deep, and a tunnel 618 ft. long, for the development of 55,000 h. p. 1400 w. Eng Rec—Feb. 16, 1901. No. 39317.

Pumps.

Cornish and Direct-Acting Duplex

Pumps. J. Renshaw. Comparison of these pumps in reference to permanent pumping plants in mines in which the water is below the temperature of about 70 or 75° Fahr. 1400 w. Min & Sci Pr—Feb. 2, 1901. No. 39198.

Turbines.

Special Report Upon Turbines and Their Regulators at the Paris Exposition of 1900 (Specialbericht über die Turbinen und deren Regulatoren au der Weltausstellung in Paris, 1900). Prof. F. Prasil. Giving details of various wheels and their governors, especial attention being devoted to the latter. Serial, Part I. 1500 w. Schweizerische Bauzeitung—Feb. 9, 1901. No. 39453 B.

Water Power.

Water Power. Brief review of methods of utilising water power. Ill. 1500 w. Engr, U. S. A.—Jan. 15, 1901. No. 39081.

Water-Wheels.

Ingenious Water-Wheels. Waldon Fawcett. Illustrates and describes some novel water-wheels in use in Nebraska and other western points, for irrigating purposes. 1000 w. Sci Am—Feb. 16, 1901. No. 39295.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings for Given Loads (Kugellager für Beliebige Belastungen). R. Stribeck. An account of tests made upon steel balls to ascertain deformation under pressure; with applications of the results to the design of ball bearings. Two articles, 10000 w. Zeitschr d Ver Deutscher Ing—Jan. 19, 26, 1901. No. 39433 each D.

See also Automobilism.

Brass.

Brass Scrap. C. Vickers. Suggestions for cleaning and using chips. 700 w. Am Mach—Jan. 31, 1901. No. 39086.

Casting.

Casting a Tangye Engine Bed. R. H. Palmer. Illustrated detailed description of the manner of making the casting. 2000 w. Am Mach—Feb. 14, 1901. No. 39321.

Centrifugal Casting. A. E. Fay. The author endeavors to give a complete history of the subject, especially describing the three important practical applications which have been made, setting forth the advantages which have been claimed and demonstrated. Ill. 3800 w. Ir Age—Feb. 28, 1901. No. 39535.

Cast-Iron Pipe.

Cast Iron Pipe in the United States. The first of a series of articles proposing to enter fully into the commercial conditions of the industry, the details of the methods of manufacture, and the forms of pipe and pipe joints used for water and gas mains and other purposes. 1600 w. Engr, Lond—Feb. 15, 1901. Serial. 1st part. No. 39520 A.

Dies.

A Forming Die. William M. Spry. Illustrates the bending die and a sample of the bent-up punching, giving description. 900 w. Am Mach—Feb. 7, 1901. No. 39181.

Drawing, Forming and Beading Shells. Joseph V. Woodworth. Illustrates and describes a set of dies for reducing a flat blank of soft sheet brass to the finished shape shown. 1300 w. Am Mach—Jan. 31, 1901. No. 39085.

Electrical Manufacturing.

Machine Tools and Outfit for Electrical Manufacturers. W. H. Booth. A discussion of the modern system of manufacture, the importance of possessing modern high-class machine tools, methods, and suggestions for improvement. 4000 w. Elec Rev, Lond—Feb. 8, 1901. No. 39377 A.

Engine Works.

A Canadian Engine Works. Norman Patterson. An illustrated article, giving a brief description of some of the processes of manufacturing practiced in the works of the Robb Engng Co., at Amherst, N. S. 2000 w. Can Elec News—Feb., 1901. No. 39342.

Foundry.

The New Steel and Iron Foundries of the Sargent Company. Illustrated description of a fine plant recently erected at Chicago Heights. Ill. 1300 w. Foundry—Feb., 1901. No. 39147.

Foundry Iron.

Foundry Iron. Captain Henning. Showing that chemical and physical investigations are of value to the foundry industry and equally necessary at the blast furnace to secure reliable results. 1200 w. Jour Am Found Assn—Feb., 1901. No. 39056 C.

Foundry Notes.

Ladles and Floor Molding. William Pilton. Illustrated description of appliances and methods used in the foundry of the Niles Tool Works Co. 800 w. Am Mach—Feb. 7, 1901. No. 39180.

Gear Cutting.

The Bilgram Automatic Generating Gear Cutter for Spur and Spiral Gears. Illustrates and describes the machine and its action. 1300 w. Am Mach—Jan. 31, 1901. No. 39087.

Gearing.

High Speed Toothed Gearing. James Christie. A record of what has been done in recent years, as much higher speeds are now successfully attained than formerly. Ill. 1500 w. Pro Engs' Club of Phila—Feb., 1901. No. 39239 D.

Interchangeable Gearing. Wilfrid Lewis. Advocating the general use of the involute system with an obliquity of 22½°, to avoid interference in low-numbered pinions. 4000 w. Pro Engs' Club of Phila—Feb., 1901. No. 39240 D.

Jigs.

A Common Drilling Jig. D. E. MacCarthy. Illustrated description of jig for drilling odd holes in a casting. 300 w. Am Mach—Feb. 7, 1901. No. 39183.

Processes of Jig Making. C. H. Rowe. Gives methods in use for the building of parts of jigs and the exact locating of holes. 1600 w. Am Mach—Feb. 7, 1901. No. 39182.

Lathes.

A New, Heavy Pattern, Two Spindle Lathe. Illustrated description of redesigned McCabe lathe. 800 w. Am Mach—Feb. 7, 1901. No. 39178.

Boring Head and Foot-Stocks of Lathes. A. B. Christman. Illustrates and briefly describes a method of finishing head and tail stocks, which the writer considers ideal. 300 w. Am Mach—Feb. 7, 1901. No. 39179.

Machine Tools.

Experiments on the Work of Machine Tools (Experiences sur le Travail des Machines Outils). M. Codron. The first portion is devoted to experiments with grinding machines, the power consumed being dynamometrically measured. Serial. Part I. 7500 w. Bull Soc d'Encour—Jan., 1901. No. 39425 G.

Light Lathes and Screw Machines. John Ashford. Considers the requirements of a present-day lathe for tool and ordinary work and how they may be fulfilled. Discusses various machine tools. Fully illustrated. 1500 w. Inst of Mech Engs—Feb. 15, 1901. No. 39528 D.

Manufacturing Plant.

A Modern Manufacturing Plant. Illustrated description of the new establishment of the Franklin Air Compressor Company, at Franklin, Pa. 1500 w. Ry Age—Feb. 22, 1901. No. 39394.

Molding.

Molding a Grinder Bed. An illustrated account of a novel and interesting molding operation. 1000 w. Am Mach—Feb. 21, 1901. No. 39381.

Pattern Working.

Thin Rings. John M. Richardson. Illustrated description of different methods of making thin ring patterns. 800 w. Am Mach—Feb. 14, 1901. No. 39322.

Premium Plan.

Spoiled Work—Inspection and the Use of Limits Under the Premium Plan. G. H. Hall. Advocating the charging of the workman with the time required to rectify spoiled work, and work beyond the established limits of variation. 1700 w. Am Mach—Feb. 14, 1901. No. 39320.

Rod Mills.

Record of Rod Mills and What Has Been Accomplished. William Garrett. A review of the progress in this field. 2500 w. Am Mfr—Feb. 21, 1901. No. 39393.

Rolling Mill.

Improved Mill for Rolling Edges Together with Flat Shapers. Albert G. Heinle. An illustration of the Heinle-Truxall rolling mill, with description of interesting features and operation. 1300 w. Am Mfr—Jan. 31, 1901. No. 39149.

Sampling.

Sampling Pig Iron. W. G. Scott. Discusses methods of sampling, and mixing by analysis. 2500 w. Foundry—Feb., 1901. Serial. 1st part. No. 39148.

Screw Threads.

International System of Metric Screw Threads (Système International des Filetages à Base Metrique). A review of the system proposed at Zurich, in 1898, together with the recent discussion concerning the dimensions of keys and wrenches. 7500 w. Bull Soc d'Encour—Jan., 1901. No. 39426 G.

Shop Equipment.

The Hardening and Tempering Plant of J. H. Williams & Co. Illustrated detailed description of the hardening and tempering equipment of a shop in Brooklyn, N. Y., and the methods employed. 2000 w. Ir Age—Feb. 7, 1901. No. 39172.

Shop Methods.

Recent Improvements in Technology (Ueber einige Technologische Neuerungen). Prof. F. Kick. A discussion of a number of shop methods and processes, mostly seen in a tour of Germany, Belgium, and Switzerland. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 25, 1901. No. 39443 B.

Shops.

An English Machine-Tool Shop. Illustrated description of the new workshops of Kendall & Gent, Belle Vue Station, Manchester, England. 900 w. Am Mach—Feb. 7, 1901. No. 39177.

Worm Gearing.

The Action of Worms and Worm-Wheels (Engrènement des Vis et Roues Héliçoidales). A translation of the paper of M. Ernst, recently presented before the *Verein deutscher Ingenieure*. Serial. Part I. 5000 w. Rev De Mécanique—Jan., 1901. No. 39423 H.

MATERIALS OF CONSTRUCTION.

Alloy.

A Useful Zinc Alloy. Walter J. May. Describes an alloy very useful in foundries and other places where it is desirable to

have an easily milled metal of fair strength. 200 w. Sci Am—Feb. 2, 1901. No. 39102.

Beams.

Diagrams for Laying Out Beams of Uniform Strength. E. Kallberg. Gives diagrams of special use in the design of stakes for steam and hydraulic riveting machines, with directions for the method of using. 500 w. Am Mach—Feb. 21, 1901. No. 39382.

Bending.

The Stresses in Bent Prismatic Bodies (Beitrag zur Bestimmung der Beigungspannung in Gekrümmten Stabförmigen Korpern). A. Bantlin. A mathematical investigation, with practical applications to hooks, riveting machine frames, etc. Two articles. 7500 w. Zeitschr de Ver Deutscher Ing—Feb. 2, 9, 1901. No. 39-437 each D.

Cast Iron.

Experiments on the Crushing Resistance of Cast Iron (Versuche über die Druckfestigkeit Hochwertigen Gusseisens). C. Bach. Data and results of tests, with especial reference to the dependence of strength to temperature. 1500 w. Zeitschr d Ver Deutscher Ing—Feb. 2, 1901. No. 39438 D.

POWER AND TRANSMISSION.

Belts.

Belt-Driving—Its History and Advantages. John Tullis. Read before the West of Scotland Tech. Col. Sci. Soc. Reviews the history, and gives information concerning the care and management of the belts, and various systems of driving. Ill. 3500 w. Am Mfr—Jan. 31, 1901. No. 39151.

Power Plants.

Power Plant Engineering, Past and Present. Editorial review of the progress in this field during the last century. 2700 w. Engr, U. S. A.—Jan. 15, 1901. No. 39083.

Power Plant of the McCormick Twine Mills. Illustrated detailed description. 2500 w. W Elect'n—Feb. 16, 1901. No. 39339.

Wire Ropes.

The Manufacture and Use of Wire Ropes. Brief account of this invention with illustrated descriptions of systems of transport. 2200 w. Ir & Coal Trds Rev—Feb. 8, 1901. No. 39367 A.

SPECIAL MOTORS.

Explosion Motors.

The Calculation of Explosion Motors for Vehicles (Le Calcul des Moteurs à Explosion pour Voitures). P. Colardeau. A discussion of the data upon which the power should be based, with tabulated information concerning existing standard vehicles. 2000 w. Génie Civil—Jan. 26, 1901. No. 39405 D.

Exposition.

Motors Other Than Steam Engines at the Paris Exposition (Les Moteurs autres que ceux à Vapeur à l'Exposition de 1900). G. Leroux. A general review of the gas, petroleum, hot air and similar motors exhibited at Paris. 5000 w. Soc Ing Civ de France—Dec., 1900. No. 39-429 G.

Gas Engines.

Gas Engine Guarantees Technically Considered. William T. Magruder. Presented at meeting of the Nat. Assn. of Gas & Gasoline Eng. Mfrs. Outlines the history of these engines, and considers power rating, regulation, cost of running and fuel consumption. 4500 w. Power—Feb., 1901. No. 39065.

The Gas Engine. Illustrated historical review. 2800 w. Engr, U. S. A.—Jan. 15, 1901. No. 39082.

Weight in Gas Engines. E. W. Roberts. Discusses why gas engines are so heavy, and points out ways and means for obtaining the lightest practical engine within keeping with strength and efficiency. 3300 w. Rudder—Feb., 1901. No. 39090 C.

Solar Power.

A Solar Motor. Brief illustrated description of a device for utilizing the sun's heat, recently erected in South Pasadena. Cal. 450 w. Ry & Engng Rev—Feb. 23, 1901. No. 39397.

STEAM ENGINEERING.

Air Pumps.

Condenser Air Pumps. W. H. Booth. On the importance of inspection and attention to small leaks. 1300 w. Am Mach—Jan. 31, 1901. No. 39088.

Boilers.

Steam Boilers and Electric Stations. Discusses points concerning the choice of a type of boiler for a given pressure of steam, the working principles, and other matters of importance. 2300 w. Elec Rev, Lond—Feb. 15, 1901. No. 39509 A.

The Boiler. One of a series of articles on the evolution of apparatus for generating and utilising power. An illustrated review of the various improvements. 4000 w. Engr, U. S. A.—Jan. 15, 1901. No. 39074.

See Marine and Naval Engineering.

Boiler Plates.

Thicker Boiler Plates. R. S. Hale. Discusses the old and the present limits and the reasons for them. 1000 w. Power—Feb., 1901. No. 39064.

Combustion.

Economy in Fuel Combustion and Steam Generation. W. W. Christie. A

study of boiler and furnace design, with reference to the production of steam with highest economy. The principles of furnace and chimney design are discussed. 4000 w. Engineering Magazine—March, 1901. No. 39472 B.

Compound Engines.

The Brand and L'Huillier Compound Engine of 150 Horse Power (Machine à Vapeur Compound de 150 Chevaux Système Brand et Huillier). A. Boudon. Illustrated description of Corliss and Poppet-valve cross-compound engine exhibited at Paris. 1000 w. 1 plate. Génie Civil—Feb. 9, 1901. No. 39410 D.

1,000-H. P. Compound Engine at the Paris Exposition. An illustrated description of an engine built by the Erste Brünner Maschinen-Fabriks-Gesellschaft, of Brünn, Austria. 500 w. Eng News—Feb. 14, 1901. No. 39257.

Compression.

The Influence of Clearance and Compression Upon Steam Consumption (Ein fluss des Schädlichen Raumes und der Kompression auf den Dampfverbrauch). H. Dubbel. A review of the researches of Zeuner, Doerfel, Dwelshauvers, and others, showing little or no loss due to compression, and attributing the results of Dwelshauvers to leaky valves and piston. 4000 w. Zeitschr d Ver Deutscher Ing—Feb. 9, 1901. No. 39439 D.

Connecting Rods.

The Problem of the Connecting Rod. W. F. Durand. A mathematical investigation of the motion of the connecting rod, including its acceleration, plus and minus during a revolution, together with the forces which are manifested as a result of much variable movement. 2000 w. Sib Jour of Engng—Feb., 1901. Serial. 1st part. No. 39530 C.

Engines.

The Stationary Engine. An illustrated review of the various stages in the development of this class. 6500 w. Engr, U. S. A.—Jan. 15, 1901. No. 39075.

Feed-Water.

Boiler Feeding and Feed-Water Heating. L. B. Mather. Discusses some methods of heating and means of delivering the feed water. 1200 w. Am Elect'n—Feb., 1901. No. 39185.

The Practical Purification of Feed Water (Considerations Pratiques sur l'Epuration des Eaux). J. Bertrand. Discussing especially the removal of carbonates by heat, and sulphates by lime and soda. 1500 w. Génie Civil—Jan. 19, 1901. No. 39402 D.

The Solubility of Sulphate of Lime (Etude sur la Solubilité du Sulfate de Chaux). M. Boyer-Guillon. An exhaustive account of experiments, showing the gradual manner in which the sulphate is precipitated as the temperature rises. 4500 w. Rev de Mécanique—Jan., 1901. No. 39421 H.

Heating.

The Steam Heating and Ventilating Plant at the Liesing Brewery (Dampfheizungs und Lüftungsaulage im Saalbau der Brauerei Liesing). J. H. Klinger. With plans and details of the steam heating of a large public hall in connection with a brewery in Vienna. 2500 w. 1 plate. Gesundheits-Ingenieure—Jan. 31, 1901. No. 39454 B.

Indicators.

The Indicator. Illustrated review of the important improvements on the instrument invented by James Watt. 1500 w. Engr, U. S. A.—Jan. 15, 1901. No. 39079.

Low Water.

Low Water Alarms and Laws Concerning Their Use. Abstract of a paper by F. C. Base, read before the International Convention of Inspectors at Indianapolis. Reasons for requiring the adoption of these alarms, with comments on the devices. 2400 w. Engr, U. S. A.—Feb. 15, 1901. No. 39351.

Marine Engines.

See Marine and Naval Engineering.

Mechanical Draft.

Application of Mechanical Draft to Stationary Boilers. Walter B. Snow. Considers the advantages of mechanical draft and shows that it costs less for installation than the chimney. Ill. 3000 w. W Elect'n—Feb. 16, 1901. No. 39340.

Power Tables.

Piston Speed. The first of a set of tables dealing with horse-power and other calculations connected with indicator diagrams, and steam engine capacities and efficiencies. It is desired that their accuracy shall be above question. 1000 w. Power—Feb., 1901. Serial. 1st part. No. 39066.

Rotary Engine.

The Colwell Rotary Engine, Reciprocating Engine and Condenser. Illustrates and describes recent inventions of W. S. Colwell, which possess features of interest. 2000 w. Sci Am Sup—Feb. 2, 1901. No. 39101.

The Hult Rotary Engine (Le Moteur Rotatif Hult). E. Dieudonné. An illustrated description of this Swedish rotary engine, exhibited at Paris. 1800 w. Revue Technique—Jan. 25, 1901. No. 39413 D.

The Rotary Engine, and the Steam Turbine. A note on the rotary engine work, and an illustrated review of the steam turbine. 1800 w. Engr, U. S. A.—Jan. 15, 1901. No. 39078.

Steam Heating.

Heating from Central Stations. Alton D. Adams. Urging the distribution of steam and hot-water for heating purposes, giving figures relating to efficiency, cost, etc., and reasons for advocating a combined electric and heating plant. 1200 w. Munic Engng—Feb., 1901. No. 39118 C.

Some Notes on Central Station Heating. Read at meeting of the Heat. & Ven. Engs., at N. Y. Gives a review of the systems that have been employed, their advantages, and complications. 7000 w.

Steam Turbine.

Test of a 300 Horse Power de Laval Steam Turbine (Versuche an einer 300 Pferdigen de Laval-Dampfturbine). W. Jacobson. Giving data and results of trials showing a consumption of 15 to 18 pounds of water per brake horse-power-hour. 1200 w. Zeitschr d Ver Deutscher Ing—Feb. 2, 1901. No. 39436 D.

Units.

Engine and Generator Builder's Engine Type Units for Power Purposes. H. C. Ebert. Abstract of paper read at N. Y. meeting of the Eng. Builds.' Assn. of the U. S. Deals especially with engine type electric generating sets. 2200 w. Ir Age—Feb. 14, 1901. No. 39253.

Water-Tubes.

On the Tubes of Water-Tube Boilers. A general reply to the question of how to calculate the force which tends to draw a tube, in a water-tube boiler, out of the header or tube sheet to which it is secured. Ill. 2000 w. Locomotive—Dec., 1900. No. 39084.

Valve Diagram.

Laying Out a Valve Gear Diagram for a Corliss Valve Air Compressor. A. L. Goddard. Considers the laying out of a diagram for a two-stage Corliss valve compressor to compress 4,000 cu. ft, net of free air from an atmosphere of 14½ pounds to 100 pounds gauge at a piston speed of 600 feet per minute. Ill. 3000 w. Wis Engr—Jan., 1901. Serial. 1st part. No. 39308 D.

MISCELLANY.

Agricultural Machinery.

The Agriculture of the Future (L'Agriculture de l'Avenir). A. Ronna. With especial reference to the use of hydraulically operated machinery. 10000 w. Bull Soc d'Encour—Jan., 1901. No. 39424 G.

Aeronautics.

A New Flying Machine. Illustrated description of an ingenious machine recently designed by G. L. O. Davidson, of Scotland. It resembles a large bird with wings extended. 800 w. Sci Am—Feb. 2, 1901. No. 39100.

Arbitration.

Arbitration in Practice. H. W. Hoyt. An address before the Nat. Civic Fed. Conference, in Chicago. On the work of the Nat. Founders' Assn. in this field. 2300 w. Ir Trd Rev—Feb. 7, 1901. No. 39211.

Clock.

The Philadelphia City Hall Clock. Warren S. Johnson. Briefly explains the principles under which an accurate timepiece must work, and the problems encountered in the installation of the clock named, and the apparatus used. Ill. 5800 w. Jour Fr Inst—Feb., 1901. No. 39189 D.

Competition.

American Engineering Competition. Discusses the economic effects and their duration, the elements of success attending the management of large business concerns in the United States, and the difference between the spirit animating the working classes on either side of the Atlantic. 2200 w. Jour Gas Lgt—Jan. 29, 1901. Serial. 1st part. No. 39272 A.

Some Reflections Upon American Competition. George Harrison Sheffield. Paper read before the Newcastle-upon-Tyne Assn. of Students of the Inst. of Civil Engs. Discusses causes which are the outcome of American competition, and British conditions and tendencies. 6000 w. Engng—Feb. 1, 1901. No. 39291 A.

Education.

A Workingman's College. An illustrated account of the educational work at Cooper Union, New York. 5300 w. Ir Age—Feb. 7, 1901. No. 39173.

Elevators.

The Elevators at the Exposition of 1900 (Les Ascenseurs à l'Exposition de 1900). P. Dumesil. Detailed description of the various elevators, hydraulic, pneumatic, and electric, operated in all parts of the exposition. Three articles. 5000 w. Génie Civil—Jan. 19, 26, Feb. 2, 1901. No. 39401 each D.

Metric System.

The Metric System. W. H. Sargent. A discussion of its possibilities as a universal system. 1500 w. Mach, N. Y.—Feb., 1901. No. 39146.

Ventilation.

Ventilation and Heating of the American Exchange National Bank, New York. Illustrated description of a plenum system for the basement and first story of a 16-story office building, and an exhaust system for the same floors discharging through the cellar; also gives brief notes on other mechanical plant in the building. 2500 w. Eng Rec—Feb. 16, 1901. No. 39319.

MINING AND METALLURGY

COAL AND COKE.

Austria.

The Rossitz Coal District (Das Rossitzer Kohlenrevier). J. Sauer. A description of the geology and methods of mining in this important coal district of Moravia, Austria. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 19, 1901. No 39449 B.

Canada.

The Coal and Iron Industries of Eastern Canada. J. Stiven Barrie. A paper read before the West of Scotland Iron & Steel Inst. A review of the development of these industries and their present condition. 3800 w. Gol Guard—Feb. 15, 1901. No. 39525 A.

China.

The Tong Colliery, Kaiping, North China. Thomas Webster. From the Pro. of the So. Wales Inst. of Min. Engs. A description of the coal seams, methods of working, and the machinery used. 3800 w. Mines & Min—Feb., 1901. No. 39-127 C.

Compressed Air.

Compressed Air Plant at a German Colliery. C. Jüngst, in *Zeitschrift für Berg, Hütten und Salinenwesen.* Illustrated description of plant at the Royal Camphausen Colliery, for driving the pumps, ventilating fans and winches. 2000 w. Col Guard—Feb. 8, 1901. No. 39366 A.

English Collieries.

The South Hetton Coal Company's Collieries and Their Equipment. Interesting account of the collieries of South Hetton and Murton; the latter is said to be the most arduous, difficult and expensive mining undertaking on record. Ill. 3200 w. Ir & Coal Trds Rev—Feb. 1, 1901. Serial. 1st part. No. 39278 A.

New Zealand.

The Supposed Coal Seam on Kaita Range, Near Greymouth. Alexander McKay. Report of the government geologist concerning an outcrop of coal-conglomerate in New Zealand. 1400 w. N. Z. Mines Rec—Dec. 17, 1901. No. 39353 B.

Russia.

The Russian Coal and Pig-Iron Industry. Dr. Neumark. A lecture delivered at the general meeting of the ironmasters of Upper Silesia. Translated and condensed from *Stahl und Eisen.* General information of these important industries, with special reference to that of Southern Russia. 2300 w. Ir & Coal Trds Rev—Feb. 15, 1901. Serial. 1st part. No. 39-515 A.

Virginia.

Norton Coal Mines at Norton, Virginia. Robert Fleming. An illustrated description of the mines, the coal seams, and the methods of mining and handling the coal. 1200 w. Mines & Min—Feb., 1901. No. 39120 C.

COPPER.

Mount Lyell.

Native Copper at Mount Lyell. G. Thureau. On the peculiarities in the mode occurrence and the causes. 300 w. Aust Min Stand—Jan. 10, 1901. No. 39357 B.

New Zealand.

Native Copper at Kawan Island, New Zealand. W. H. Baker. On the occurrence of native copper in the crystalline state on mine timbers. 1000 w. N. Z. Mines Rec—Dec. 17, 1900. No. 39355 B.

Precipitation.

Precipitation of Copper From Its Solutions. Arthur W. Warwick. Notes on the precipitation of copper from its solution by iron. 600 w. Min Rept—Feb. 7, 1901. Serial. 1st part. No. 39241.

Smelting Works.

The British Columbia Copper Company's Smelting Works at Greenwood, B. C. Paul Johnson. Illustrated detailed description. 1800 w. Eng & Min Jour—Feb. 16, 1901. No. 39338.

Tasmania.

Notes on the Occurrence of Native Copper at Mt. Lyell, West Coast of Tasmania, with Observation Upon the Genesis of the Ores. G. Thureau. 4500 w. Min Jour—Jan. 26, 1901. No. 39270 A.

Tennessee Plant.

The Tennessee Copper Company's New Plant. A brief description of a plant in the Ducktown District for the development of copper ore deposits. 1000 w. Eng & Min Jour—Feb. 16, 1901. No. 39336.

GOLD AND SILVER.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. Mr. Charleton's second paper treats of the general geology of the western Australian fields, and the process of dry-blowing made necessary by the scarcity of water. 4500 w. Engineering Magazine—March, 1901. No. 39473 B.

British Columbia.

Placer Gold Mining Claims in British Columbia. A brief statement of the laws governing the locating and working of placer claims. 1300 w. U. S. Cons Repts, No. 956—Feb. 8, 1901. No. 39174 D.

California.

The Gold Mines of California (Les Mines d'Or de la Californie). A. Bordeaux. A study of gold mining in California, from a geological standpoint. Serial, Part I. 7500 w. 3 plates. Rev Univ des Mines—Jan., 1901. No. 39417 F.

Concentration.

Concentrating Tests and Calculations. Otto F. Pfordte. The necessity of a finer system of testing is presented, and suggestions of tests to be applied are given. 2000 w. Trans Am Inst of Min Engs—Feb., 1901. No. 39228 C.

Cripple Creek.

The Gold Coin Mine. Arthur Lakes. A history of its development and a description of the mines, the surface plant and miners' club-house. Ill. 2000 w. Mines & Min—Feb., 1901. No. 39121 C.

Deposits.

Cave Ore Deposits. Arthur Lakes. Illustrated description of peculiar deposits of silver and copper ores in caves at the Red Mountain mines, Colorado. 2200 w. Mines & Min—Feb., 1901. No. 39128 C.

Gold Milling.

Electro-Silvered versus Plain Copper Plates. Edward Halse. Considers that for a certain class of ore electro-silvered plates catch more gold in proportion than the plain copper plates working under similar conditions, but that such gold is of an increased fineness. 1500 w. Eng & Min Jour—Feb. 16, 1901. No. 39337.

Note on Cheap Gold-Milling in Mexico. Henry F. Collins. Describes the ore-body, the mining and milling, giving cost. 1000 w. Trans of the Am Inst of Min Engs—Feb., 1901. No. 39227 C.

Gold Mining.

Important Mining Development at the Great Barrier Island. From the *Auckland* Star. Describes the Barrier Reefs mine, and the reduction plant. 2200 w. N. Z. Mines Rec—Dec. 17, 1900. No. 39354 B.

Idaho.

Buffalo Hump, Idaho. D. G. Doubleday. Facts about a gold mining region which is attracting great attention and promises well. Ill. 2200 w. Mines & Min—Feb., 1901. No. 39123 C.

Melting Point.

On the Melting Point of Gold. Ludwig Holborn and Arthur L. Day. Describes experimental investigations. 1200 w. Am Jour of Sci—Feb., 1901. No. 39188 D.

Refining.

Description of an Improved Apparatus or Method of Desilverizing Base Bullion. Stephen Tredinnick. Illustrates and describes the writer's series apparatus and its working, comparing with other processes. 3000 w. W Min Wld—Feb. 9, 1901. No. 39242.

Sludges.

Extraction of Gold From Sludges. From the *Queensland Government Mining Journal.* Particulars regarding a method of successful cyanide treatment. 900 w. N. Z. Mines Rec—Dec. 17, 1901. No. 39356 B.

Tailings.

Cyaniding Stamp Mill Tailings in Western America. William Magenau. A description of the Dexter Gold Mining Company's plant at Tuscarora, Nevada. 3300 w. Mines & Min—Feb., 1901. No. 39124 C.

IRON AND STEEL.

Blast Furnaces.

New Blast Furnace at Couillet (Belgium). Illustrated description. The special feature consists in the shaft being entirely independent of the mouth and the closing and charging appliances. 2000 w. Col Guard—Jan. 25, 1901. No. 39167 A.

France.

Influence of the Exposition on the French Iron and Steel Industry. Henri Guérin. A review of the successive developments which have followed the various expositions, and a review of the present status of the iron and steel industries of France. 3500 w. Engineering Magazine—March, 1901. No. 39474 B.

Furnace Gas.

See Gas Engineering.

Hardening.

Preparation of Steel, and Points on Hardening. E. R. Markham. On the treatment of tool steel. 1600 w. Loc Engng—Feb., 1901. No. 39111 C.

Iron Trade.

Lake Superior Iron Trade During 1900. Dwight E. Woodbridge. Concerning the output and growth of the industry, the ore reserves, and the conditions of ownership and transportation. 3500 w. Mines & Min—Feb., 1901. No. 39126 C.

Russia.

The Iron and Steel Industries of the Urals. G. Kamensky. A review of this industry, the output and methods. The pig-iron is smelted exclusively on charcoal fuel. 1400 w. Ir & Coal Trds Rev—Feb. 1, 1901. No. 39279 A.

Steel Trust.

The Great Consolidation. Concerning a movement to place practically the whole of the steel trade of the Central West in the United States, under one control. 4800 w. Ir Age—Feb. 14, 1901. No. 39255.

The Great Consolidation. Discusses the basis of exchange of securities, fixed charges, advantages claimed, outside in-

terests, prices, etc. 3800 w. Ir Age—Feb. 28, 1901. No. 39537.

The Giant Steel Trust. Editorial discussion of the recent combination of large steel producers in America. 1800 w. Engr, Lond—Feb. 15, 1901. No. 39523 A.

The Great Steel Trust. Editorial discussion of the combination of the steel industries in America, and the outlook. 2200 w. Engng—Feb. 15, 1901. No. 39519 A.

The United States Steel Corporation. Text of the articles of incorporation filed with the State Department of New Jersey on Feb. 25, 1901. 2500 w. Ir Age—Feb. 28, 1901. No. 39536.

Tempering.

On the Tempering of Iron Hardened by Overstrain. James Muir. Abstract of a paper communicated by Prof. Ewing, read before the Royal Soc. The work described is a continuation of that described in a paper by the present author, "On the Recovery of Iron From Overstrain." 1500 w. Engng—Jan. 25, 1901. No. 39165 A.

MINING.

Arizona.

The Geology and Vein-Phenomena of Arizona. Dr. Theo. B. Comstock. Describes the structural geology and mineral belts, the vein structure, and disturbances, reviewing the stratigraphy and its economic relations. 24000 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39222 D.

Exploration.

The Diamond Drill in Exploration Work. Dr. Emil E. Lungwitz. Discusses the conditions favorable to the use of these drills, and the results. 1500 w. Min Jour—Jan. 26, 1901. Serial. 1st part. No. 39269 A.

Explosives.

Explosives Used in Metal Mining Harold Harris. Read before the N. S. W. Chamber of Mines. A brief description of the nitroglycerine mixtures, with remarks on their manufacture and uses in mining. 3200 w. Aust Min Stand—Jan. 10, 1901. No. 39358 B.

Foremen.

Coal Mine Foremen and Labor-Saving Devices. L. C. Morganroth. Discusses the duties of the foreman, and some of the devices in use in different mines. 2000 w. Eng & Min Jour—Feb. 16, 1901. No. 39335.

India.

Metalliferous Mining in India. John W. Evans. Concerning Peninsular India only, its geology and ores, methods of working, etc. Does not deal with the iron deposits, but briefly considers the copper, lead, silver, zinc, tin, etc., and more fully the deposits and mining of gold. General discussion. 20900 w. Jour Soc of Arts—Feb. 1, 1901. No. 39271 A.

Instruments.

See Civil Engineering, Measurement.

Mine Maps.

When in Black and White. Claude V. Martin. Read before the Ohio Inst. of Min. Engs. Some suggestions in regard to the attainment of a neat and clear appearance in the making of mine maps. 1500 w. Mines & Min—Feb., 1901. No. 39125 C.

Mining Plant.

See Electrical Engineering, Power.

Pumping.

The Pumping Machinery of the Bruch Colliery (Wasserwirthschaft der Gewerkschaft Brucher Kohlenwerke). A. Padour. Illustrated description of horizontal, underground pumping machinery in the colliery at Bruch, in northwestern Bohemia. 3500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 9, 1901. No. 39450 B.

Shaft-Sinking.

Difficulties in Congelation for Sinking and Deepening an Abandoned Shaft. An illustrated account of the difficulties and the means of overcoming them. 2800 w. Col Guard—Jan. 25, 1901. No. 39168 A.

The Deep Sinking of Shafts at the Sydney Harbor Colliery. Interesting particulars concerning the work, with illustrations. 4400 w. Col Guard—Feb. 1, 1901. No. 39284 A.

Tunnels.

The Opening of Mines by Tunnels. D. W. Brunton. An illustrated description of methods of timbering, operating, etc. 1600 w. Eng & Min Jour—Feb. 2, 1901. No. 39144.

Veins.

The Origin of Vein Cavities. Frank L. Nason. The present article considers fissure veins, discussing their peculiarities, causes, etc. 2500 w. Eng & Min Jour—Feb. 9, 1901. Serial. 1st part. No. 39267.

Volume.

A Method for Obtaining the Volume of Small Drifts and Working-Places, Where It Is Impossible to Use a Transit. Discussion of paper by C. S. Herzig. 600 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39226 C.

Winding-Ropes.

The Testing of Winding Ropes in the Province of Anhalt, Germany. Frank H. Probert. Notes on the method of testing and the results obtained. Ill. 2500 w. Trans Am Inst of Min Engs—Aug., 1900. No. 39229 D.

MISCELLANY.

Aluminum.

Aluminum at the Paris Exposition (1900). Joseph W. Richards. Remarks

on the present position of the metal, and description of the exhibits. 2500 w. Jour Fr. Inst—Feb., 1901. No. 39190 D.

Diamonds.

Diamonds in Volcanic Breccia. E. F. Pittman. Describes the discovery of diamonds in the breccia taken out of a shaft on Ruby Hill in Australia, and the conclusions drawn. 1800 w. Aust Min Stand—Dec. 20, 1900. No. 39069 B

Exposition.

The Mining Exhibits at the Exposition of 1900 (L'Exploitation des Mines à l'Exposition de 1900). H. Schmerber. The first installment relates principally to the French collieries. 2500 w. Génie Civil—Feb. 2, 1901. No. 39407 D.

Korea.

Mining Conditions in Korea. Describes the country, climate and customs. 1000 w. Min & Sci Pr—Jan. 26, 1901. No. 39089.

Madagascar.

The Mineral Riches of the French Colonies—Madagascar (Les Richesses Minérales des Colonies Françaises-Madagascar). L. Pelatan. A general review of the geology of the island, showing the presence of gold and other metals, as well as coal. 7500 w. Rev Univ des Mines—Dec., 1900. No. 39415 F.

Nitrate of Soda.

The Nitrate of Soda Industry. Illustrates and describes the nitrate beds in Chile, and the methods employed in opening them and preparing the product for the market. 1100 w. Eng & Min Jour—Feb. 23, 1901. No. 39395.

Ore Deposits.

The Secondary Enrichment of Ore-Deposits. Arthur L. Collins. Discussion of the papers of Messrs. Emmons and Weed. 700 w. Trans Am Inst of Min Engs—Feb., 1901. No. 39225 C.

Petroleum.

On the Classification of Crude Petroleums. S. F. Peckham. Read at the Congress in Paris and revised for publication. An account of researches made in this field, with suggestions for a system of classification. 3500 w. Jour Fr Inst—Feb., 1901. No. 39191 D.

Petroleum in California. From the *Oil, Paint and Drug Reporter*. Reviews the history of the development of these deposits, and the present outlook. 1800 w. Pro Age—Feb. 15, 1901. No. 39345.

Petroleum Indications at Deep Creek, Lake Brunner. Alexander McKay. Report of the government geologist concerning the indications of oil found, with description of the geology of the district, and other information. 1800 w. N. Z. Mines Rec—Dec. 17, 1900. No. 39352 B.

The Beaumont Oil Field, Texas. William B. Phillips. General information in regard to this great oil producer, recently discovered. Ill. 2800 w. Eng & Min Jour—Feb. 9, 1901. No. 39266.

Russia.

The Russian Coal and Pig Iron Industry (Die Russische Kohlen und Roheisen Industrie). Dr. Neumark. Especially discussing the products of southern Russia, with tabulated statistics and maps. Two articles, 7500 w. 2 plates. Stahl und Eisen—Jan. 15, Feb. 1, 1901. No. 39440 each D.

Slate.

The Slate Quarries of Angers (Notes sur les Ardoisières d'Angers). J. Kersten. A discussion of the geology of the region and an account of the working of the quarries in Anjou. 3000 w. Rev Univ des Mines—Dec., 1900. No. 39414 F.

Sulphur.

Sulphur. Edward W. Parker. Extract from the annual report of the U. S. Geol. Survey. Information relating to the amount consumed in the United States, where it is produced, and the methods of reducing the ores. 3300 w. Mines & Min—Feb., 1901. No. 39122 C.

Tin.

The Greenbushes Tinfields (W. A.) Describes a deposit in southwest Australia, and also the smelting works. 2000 w. Aust Min Stand—Dec. 20, 1900. No. 39070 B.

Utah.

A New Mining Region. Don Maguire. An account of a new locality for mining, comprising the greater part of Box Elder county. The ores are gold, silver, copper, lead, zinc, antimony, iron, nickel, cobalt, etc. Also illustrations showing the difficulties met in constructing the aerial tramway. 2000 w. Min & Sci Pr—Feb. 16, 1901. No. 39500.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

An Accident at Offenbach, Germany. Official translation of a report of the officers of the Prussian State Railroad Administration concerning an accident that caused loss of life. 1300 w. R R Gaz—Feb. 8, 1901. No. 39213.

Train Accidents in 1900. A tabulated

statement of train accidents for 28 years, their nature and cause; also of casualties to passengers and employees during 1900, with remarks on the accidents. 1500 w. R R Gaz—Feb. 15, 1901. No. 39301.

Train Accidents in the United States in December. Detailed list and classified summary for the month. 3000 w. R R Gaz—Feb. 1, 1901. No. 39117.

Education.

The Education of Railroad Men for Subordinate Positions of Responsibility. Walter S. Berg. Address before the Convention at St. Louis. Deals particularly with reference to employees of the bridge and building department of railroads. 7300 w. Pro. of Assn. of Ry Supts of Bdgs & Bldgs—Oct., 1900. No. 39159 D.

European Railways.

European Railway Jottings. Charles Rous-Marten. Notes on British train service during the last year of the century. 1600 w. Loc Engng—Feb., 1901. No. 39112 C.

Fast Trains.

The Speed of Express Trains in Europe. Editorial on an article in the *Archiv für Eisenbahnwesen*, by W. Schulze, making a study of this subject. 1100 w. R R Gaz—Feb. 8, 1901. No. 39214.

Paris.

The Improvement in Local Transport in Paris (Amélioration des Transports en Commun à Paris). Marcel Delmas. A discussion of the present inadequate methods, with suggestions for improvement. 10000 w. Soc Ing Civ de France—Dec., 1900. No. 39428 G.

Rating.

A New Method of Rating and Loading Engines in Freight Service. Thomas Tait. An explanation of new method adopted by the Canadian Pacific, giving tabulated information, forms of reports, etc. General discussion follows. 13000 w. N. Y. R R Club—Jan. 17, 1901. No. 39305.

Suburban Service.

A Typical Suburban Service. An account of the service rendered by the Chicago & Northwestern R. R., in carrying rural residents to and from Chicago. Map and ills. 5200 w. Ry Age—Feb. 15, 1901. No. 39332.

MOTIVE POWER AND EQUIPMENT.

Acceleration.

Acceleration of Electric Cars. George H. Morse. The bearing of this subject on the economy of the system is discussed, the conditions to be met and the best practice. 1700 w. St Ry Jour—Feb. 2, 1901. No. 39156 D.

Accumulators.

The Accumulator as a Source of Economy in Electric Traction. W. H. Booth. Gives approximate estimates of saving and cost, and arguments favoring their use. 2400 w. Elec Rev, Lond—Jan. 25, 1901. No. 39161 A.

Air Brakes.

Air Brake Repairs. A letter from Godfrey W. Rhodes on the neglect and consequent delay of freight. 1800 w. Ry Mas Mech—Feb., 1901. No. 39240.

Increased Efficiency in Air-Brake System. Communications and discussion of this subject at January meeting. 13500 w. Cent Ry Club—Jan., 1901. No. 39328 C.

Cars.

Composite Hopper Coal Cars 100,000 Pounds Capacity. Illustrated description of cars with steel frames and wooden hoppers, built for the Norfolk & Western Ry. 1800 w. Am Engr & R R Jour—Feb., 1901. No. 39059 C.

70,000-lb. Capacity Box Cars for the Northern Pacific Ry. Plans for a 36-ft. car are given, with description. A lot of 2,750 are in process of construction. 900 w. Ry & Engng Rev—Feb. 23, 1901. No. 39396.

Structural Steel Hopper-Bottom Car of the American Car & Foundry Company. Illustrated description of an 88,000 lbs. capacity steel car. 700 w. R R Gaz—Feb. 8, 1901. No. 39212.

The "Handy" Car. Illustrated description of a new combination car, with new features in the construction of the sides and ends of the box. 900 w. R R Gaz—Feb. 1, 1901. No. 39116.

Chicago.

The South Side Overhead Electric Railway of Chicago. Illustrated description of the power-station, which furnishes power for Sprague multiple-unit system. 2500 w. Trans & Ry Wld—Jan. 10, 1901. No. 39103 A.

Couplings.

Railway Couplings. Tabulated report showing strength of standard wagon couplings, as ascertained by experiments in the testing machine at University College, Cardiff, with an account of the work. Ill. 1200 w. Engng—Feb. 15, 1901. No. 39516 A.

Exposition.

The Central Railway of France (Compagnie des Chemins de Fer du Midi). A review of the exhibits of this company, including rolling stock, tools, etc. 20000 w. 6 plates. Rev Gen d Chemins de Fer—Jan., 1901. No. 39430 H.

The General Omnibus Company (La Compagnie Générale des Omnibus). A review of the exhibits of the Paris Company, including motor cars propelled by

compressed air, electric accumulators, and steam. 8000 w. Rev Gen d Chemins d Fer—Jan., 1901. No. 39431 H.

Ganz System.

The Ganz System of Electric Traction. Describes an experimental road constructed on this system, and manner of working. 4400 w. Engr, Lond—Feb. 1, 1901. No. 39283 A.

The Ganz System of Electric Traction. Further information of this system, concerning the use made of compressed air, the safety appliances, the equipment, a comparison of costs, etc. 4500 w. Engr, Lond—Feb. 15, 1901. No. 39522 A.

Hot Boxes.

Hot Driving Boxes on Locomotives. M. E. Wells. Emphasizes the importance of care in packing, and discusses the kind of boxes, oil holes, etc. General discussion. 9000 w. W Ry Club—Jan., 1901. No. 39304 C.

Jungfrau.

Electric Locomotive No. 4 for the Jungfrau Railway (Die Elektrische Ausrüstung der Jungfraubahn lokomotive No. 4). Giving photographs of the motors and machinery; also diagrams of the wiring and charts of the performance. 3000 w. Schweizerische Bauzeitung—Feb. 2, 1901. No. 39452 B.

The Jungfrau Polyphase Electric Railway. Illustrates and describes some details of the electrical equipment. 1500 w. Elec Rev, N. Y.—Feb. 2, 1901. No. 39139.

Locomotives.

"Central Atlantic" Type Passenger Locomotive. Illustrated description of a large capacity engine with traction increaser attachment, built for the N. Y. C. & H. R. R. R. 1600 w. Am Engr & R R Jour—Feb., 1901. No. 39057 C.

Compound "Atlantic" Type Passenger Locomotive. Illustration, drawings and general dimensions of a wide-firebox engine for burning soft coal, built for the B. & O. Ry. 400 w. Am Engr & R R Jour—Feb., 1901. No. 39060 C.

Four-Wheel Coupled Locomotive for the Dutch States Railways. Illustration and dimensions of engine for heavy and fast mail service. 400 w. Engng—Feb. 1, 1901. No. 39288 A.

German Locomotives at the Exposition (Les Locomotives Allemandes à l'Exposition). D. Bellet. The first installment of a serial review of the engines exhibited by German makers at Vincennes. Serial, Part I. 2500 w. Revue Technique—Jan. 25, 1901. No. 39411 D.

Heavy 10-Wheel Compound Passenger Locomotive. Brief illustrated description of one of twenty engines built for the Union Pacific Ry., the heaviest of their type ever built. 350 w. Am Engr & R R Jour—Feb., 1901. No. 39062 C.

Locomotive Classification on the Pennsylvania. An explanation of the classification now used. 600 w. R R Gaz—Feb. 1, 1901. No. 39115.

Locomotives at the Exposition of 1900 (Les Locomotives à l'Exposition de 1900). F. Barbier. Illustrating and describing the compound express locomotives of the North Eastern and the Central Railways of Switzerland. 1200 w. 1 plate. Génie Civil—Feb. 2, 1901. No. 39406 D.

Locomotives at the Paris Exposition of 1900 (Exposition Universelle de Paris, 1900, Les Locomotives). A. Stevart. A comprehensive review by the honorary Chief Engineer of the Belgian State Railways. Serial, Part I. 5000 w. Rev Univ des Mines—Jan., 1901. No. 39416 F.

Strength and Weakness of Compound Locomotives. C. R. Petrie. States some facts brought out by the use of compounds. 600 w. Loc Engng—Feb., 1901. No. 39110 C.

The Actual Working of American Locomotives on British Railways. C. Rous-Marten. Showing the satisfactory service both in England and in British colonies, with much authentic information as to actual conditions and performances. 4500 w. Engineering Magazine—March, 1901. No. 39475 B.

The Hungarian Locomotives at the Exposition of 1900 (Les Locomotives Hongroises à l'Exposition de 1900). R. Godfernaux. Illustrated description of the three Hungarian locomotives exhibited at Vincennes. 2500 w. 1 plate. Rev Gen d Chemins de Fer—Jan., 1901. No. 39432 H.

The Locomotive. Brief illustrated outline of the changes which have led to the locomotive of the present. 2200 w. Engr, U. S. A.—Jan. 15, 1901. No. 39077.

The New Class I. Central-Atlantic Type Locomotives—New York Central Railroad. Concerning the new classification of engines on this road, with illustrated description of the new type which will pull the Empire State Express. 1800 w. R R Gaz—Feb. 1, 1901. No. 39114.

Vanderbilt Locomotive Boiler. An illustrated description of one of the two consolidation locomotives used on the B. & O. R. R., with remarks on the distinctive features. 1000 w. Sci Am—Feb. 16, 1901. No. 39293.

Motive Power.

The Glasgow Electric Tramways Engines. The engines for this project were divided between English and American makers. This article describes the two English built engines. 1500 w. Engng—Feb. 1, 1901. No. 39287 A.

Motors.

The Efficiency of Street Railway Motors (Zur Frage der Leistungsbezeichnung von Strassenbahnmotoren). M. Müller. An

examination of the conditions of action of motors in tramway service, with a view to proper powering. 3000 w. Elektrotech Zeitschr—Jan. 24, 1901. No. 39455 B.

The Control of Tramway Motors. K. Sieber, in *Elektrotechnische Zeitschrift.* Considers the advantages and disadvantages of the several systems of connection. Ill. 2500 w. Elec Engr, Lond—Jan. 25, 1901. No. 39162 A.

Sanitation.

Passenger Coach Sanitation. J. N. Hurty. From a paper read before the International Assn. of Ry. Surgeons. Suggestions for construction, ventilation, cleanliness, disinfection, etc., especially of Pullman coaches, sleeping cars, and dining cars. 2200 w. Am Engr & R R Jour—Feb., 1901. No. 39063 C.

Snow Plows.

The Use of Snow Plows and Flangers. Illustrates and describes appliances used by different railways for keeping the line open, or clearing it when blockaded by snow. 1200 w. Eng News—Jan. 31, 1901. No. 39095.

Supplies.

The Department of Tests on a Railroad. Extracts from a paper by H. B. Hodges, read before the New England R. R. Club. On the desirability of railroads maintaining their own laboratory and a system of inspection and tests of supplies purchased, giving an account of the practice of the Long Island R. R. 3800 w. R R Gaz—Feb. 15, 1901. No. 39302.

Tests.

Draft-Rigging Tests on the Atchison, Topeka & Santa Fe. Interesting information of road tests, subjecting trains to extraordinary shocks without damage to the draft-riggings or the trains. Also editorial. 2600 w. R R Gaz—Feb. 22, 1901. No. 39503.

Third Rail.

Murphy Third Rail in the Baltimore Belt Line Tunnel. States the situation of the tunnel and the arrangement for hauling traffic through it, and gives an illustrated description of the new system installed. 1500 w. Ry & Engng Rev—Feb. 2, 1901. No. 39153.

The Completion of the Albany and Hudson Third Rail Electric Railway. Illustrated detailed description of the power house, and the polyphase equipment, wiring, switchboards, sub-stations, etc. 5600 w. St Ry Jour—Feb. 2, 1901. No. 39154 D.

Tools.

Hydrostatic Tools in Railway Service. George L. Gillon. An illustrated article concerning the designs and operation of hydraulic shop jacks, wrecking jacks, transfer jacks, crank pin presses, car wheel presses, punches, rail benders, etc. Also general discussion. 12800 w. W Ry Club—Jan., 1901. No. 39303 C.

Train Heating.

Heating Passenger Trains with Exhaust Steam From the Air Pump. Illustrates and describes a system of heating used for the past two winters by the Maine Central R. R. 900 w. R R Gaz—Feb. 22, 1901. No. 39502.

Truck.

Steel Frame Passenger Truck. Brief illustrated description of a recent design for the Chemin de Fer du Nord, with springs over journal boxes. 400 w. Am Engr & R R Jour—Feb., 1901. No. 39061 C.

Underground.

Inner Circle London Underground Railway. Gives the principal points in a scheme for the electrical equipment of this road which is now operated by steam. 1000 w. Elec Wld & Engr—Feb. 2, 1901. No. 39141.

Underground Railway Construction in London. W. H. Booth. Describes the natural conditions existing, the construction, etc., criticising the methods of working, lack of proper ventilation, and faults of management. 1700 w. St Ry Jour—Feb. 2, 1901. No. 39157 D.

Wheels.

Notes on Truck Wheels. Sam Steele. Information concerning the manufacture and wear of steel-tired wheels. 1300 w. Loc Engng—Feb., 1901. No. 39108 C.

NEW PROJECTS.

Tennessee.

The Tennessee Central Railway. Illustrates and describes some of the peculiar and difficult features in construction owing to the character of the country through which the road passes. 1000 w. Engr, Lond—Jan. 25, 1901. No. 39171 A.

PERMANENT WAY AND FIXTURES.

Boston.

Unique Elevated-Underground Street Railway in Boston. J. A. Stewart. Illustrated description of interesting features of changed plans. 1200 w. Sci Am—Feb. 2, 1901. No. 39097.

Boston Subway.

Construction of the East Boston Subway and Tunnel. An illustrated description of an extension now being constructed to the underground system of rapid transit. 2000 w. Ry & Engng Rev—Feb. 16, 1901. No. 39347.

Contact System.

The Schuckert Contact System. Illustrated description of the surface contact

system of electric traction which has been tried in Munich. 2200 w. Tram & Ry Wld—Jan. 10, 1901. No. 39104 A.

Denver.

Notes on the Denver City Tramway. Illustrates and describes the track and special work, the despatching system, cars, and matters of interest in the operation and management. 6000 w. St Ry Jour—Feb. 2, 1901. No. 39155 D.

Electrolysis.

Electrolysis in the District of Columbia. Grahame H. Powell. Concerning the steps being taken to provide more stringent penalties for failure to furnish a proper metallic return for the powerful currents. Information from the report of the Commissioners of the District. 2000 w. Elec Wld & Engr—Feb. 16, 1901. No. 39324.

Huddersfield.

Huddersfield Electric Tramways. Historical account and illustrated description of this English tramway and its equipment. 8400 w. Elec Engr, Lond—Feb. 15, 1901. No. 39526 A.

Hudson River R. R.

The Hudson River Railroad. Herbert T. Walker. Reviews the interesting early history of this road, and gives an illustrated description of the "Croton," one of the early locomotives. 1500 w. R R Gaz—Feb. 15, 1901. No. 39300.

Rails.

Specifications for Steel Rails. W. R. Webster. Gives the proposed standard specifications for steel rails, recommended by the American Branch of Committee No. 1 of the International Assn. for Testing Materials, and submitted for discussion, with remarks. 2500 w. Trans Am Inst of Min Engs—Feb., 1901. No. 39-224 D.

Roadbed.

Some Interesting Roadbed Construction. Brief description of work on the London & Southwestern Ry. in widening its roadbed for a four-track line. 500 w. Ry & Engng Rec—Feb. 16, 1901. No. 39346.

Shops.

New Car Shops. Illustrates and describes a new plant for the N. Y., N. H. & H. R. R., at Readville, Mass., used exclusively for cars and having electric distribution of power. 1100 w. Am Engr & R R Jour—Feb., 1901. No. 39058 C.

Readville Car Shops—New York, New Haven & Hartford. General plan of shops being built at Readville, Mass., which will probably be the most extensive plant in the United States. Description. 1700 w. R R Gaz—Feb. 15, 1901. No. 39299.

Readville Car Shops—New York, New Haven & Hartford R. R. Illustrated article on the arrangement of tools and machinery of the blacksmith and machine shops. 1200 w. R R Gaz—Feb. 22, 1901. No. 39504.

South-Eastern Railway Works. An account of the new works of South-Eastern and Chatham Ry. Co. 1500 w. Engr, Lond—Feb. 8, 1901. No. 39372 A.

Signals.

The New Manual Interlocking Machine. Illustrated description of a machine designed on the usual system of preliminary locking, but with the locking mechanism connected directly to the rockers. The invention of Benton C. Rowell. 1100 w. Eng News—Jan. 31, 1901. No. 39091.

Steep Railways.

The Steepest Railways in the United States. Waldon Fawcett. Illustrated descriptions of the Mt. Washington Rack Railway, and the Pike's Rack Railway. 1600 w. Sci Am—Feb. 2, 1901. No. 39098.

Suburban.

Lewiston-Brunswick & Bath Street Railway. Illustrated description of interesting line in Maine, furnishing communication between villages and cities, and comprising 55 miles of track. 2400 w. St Ry Rev—Feb. 15, 1901. No. 39327 C.

Terminal.

Some Engineering Features of the Grand Central Station, New York. Illustrated description of the electric lighting, hydraulic elevator, air compressing, ventilating and heating equipment. 3500 w. Eng Rec—Feb. 23, 1901. No. 39392.

Track.

Methods of Laying Track (Pose de la Voie). H. Seymat. A comparison of the various methods of constructing the permanent way of railways at present in use. 5000 w. Soc Ing Civ de France—Dec., 1900. No. 39427 G.

Widening.

Widening the South-Western Railway. An account of the important work on the different sections, which will provide the London and South-Western Ry. with four tracks from Waterloo to Worting Junction. 2300 w. Engr, Lond—Feb. 8, 1901. No. 39373 A.

MISCELLANY.

Statistics.

Statistics of Electric Tramways in Germany (Statistik der Elektrischen Bahnen in Deutschland). The annual review giving tabulated details concerning roads in operation, under construction and projected. 12000 w. Elektrotech Zeitschr—Feb. 7, 1901. No. 39464 B.

CURRENT RECORD OF NEW BOOKS

The Book Department of THE ENGINEERING MAGAZINE *is prepared to supply any work here mentioned, at the Publisher's price, delivered post paid to any part of the world. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE. *These pages are issued separately from the Magazine, printed on one side of the paper only, for card index purposes in libraries. See introductory to "The Engineering Index."*

Lighting.

Electric Lighting. A Practical Exposition of the Art. Volume II. Distributing System and Lamps. By Francis B. Crocker, E. M., Ph. D. Price $3.00. Size 6 in. by 9 in. pp. 505. New York: D. Van Nostrand Co. London: E. & F. N. Spon.

The second volume of Professor Crocker's gives us probably the most complete and modern discussion of electrical distribution, transformation, and wiring yet published, as well as an account of arc and incandescent lamps, and electric meters. The latest revision of the National Electric Code, and the Report of the Committee on Standardization of the American Institute of Electrical Engineers are given as appendices.

Municipal Works.

Municipal Public Works. An Elementary Manual of Municipal Engineering. By Ernest M'Cullough, C. E. Price 50 cents. Size 6 in. by 9 in. pp. 153. Lewiston, Idaho. Published by the Author.

A convenient little handbook containing much useful general information concerning Streets, Drainage, Water Supply, Lighting, etc., in a form suitable for the use of non-professional men who may be on city committees, or in similar positions, where problems of municipal engineering come before them for consideration.

Electrical Measurement.

Mesures Electriques. Leçons Professées a l'Institut Electrotechnique Montefiore. Par Eric Gerard. Price 12 francs. Size 6 in by 10 in. pp. 524. Paris: Gauthier-Villars.

This volume is devoted entirely to the discussion of the measurement of electrical quantities, current, potential, resistance, capacity, etc., and of magnetic quantities, as permeability, hysteresis, etc. A chapter is devoted to standards of measurement, and one to photometry, and the subject of commercial electricity meters is briefly considered.

Copper.

The Copper Handbook. By Horace J. Stevens. Price $1.00. Size 6 in. by 9 in. pp. 314. Houghton, Michigan. Published by the Author.

A very full collection of statistics relating to the copper production, values, consumption, and exports of the United States. Also Tables of the English copper trade the world's copper production, and much general information concerning copper mining, and mining companies.

Lathes.

English and American Lathes. By Joseph Horner. Price 21s. Size 10 in. by 12 in. pp. 164. London: Whitaker & Co.

A comparative study of lathe construction in England and America, with many illustrations showing the practice in both countries. Each portion of the tool is given in a separate chapter, and the national peculiarities are studied and their respective merits and disadvantages noted. A chapter is devoted to turret lathes and one to special lathes.

Calculus.

Elementary Illustrations of the Differential and Integral Calculus. By Augustus De Morgan. Price $1.00. 5s. Size 5½ in. by 7½ in. pp. 144. Chicago: The Open Court Publishing Co.. London: Kegan Paul, Trench, Trubner & Co., Limited.

A reprint of Professor De Morgan's well-known work, long since out of print, and dealing with the fundamental principles of the calculus in a manner which clears away many of the difficulties of the subject. A brief bibliography of English, French, and German textbooks on the calculus is appended.

Mathematics.

Mathematical Essays and Recreations. By Hermann Schubert. Translated from the German by Thomas J. McCormack. Price 75 cents. 3s. 6d. Size 6 in. by 9 in. pp. 149. Chicago: The Open Court Publishing Company. London: Kegan Paul, Trench, Trubner & Co., Limited.

A collection of general essays upon mathematical subjects, including the fourth dimension, history of attempts to square the circle, the nature of mathemati-

cal knowledge, etc., etc. Professor Schubert's writings have attracted much attention in Germany, and this enables English readers to enjoy and profit by them.

Engineering Education.

Society for the Promotion of Engineering Education. Proceedings of the Eighth Annual Meeting. Vol. VIII. Edited by John B. Johnson, Albert Kingsbury, Henry S. Jacoby. Price $2.50. Size 6 in. by 9 in. pp. 376. New York: Engineering News Publishing Co.

Full report of the meeting held in New York in July last, giving the complete text of papers and discussions. The subjects cover the general theory of industrial education, engineering education in specialized branches, the attitude of technical schools toward commercial and manufacturing aspects of applied science, laboratory work, manual training, teaching methods, and the relations of the instructor. Appendices give the membership, officers and constitution of the Society. Indexed.

Cement.

The Cement Industry. Description of Portland and National Cement Plants in the United States and Europe, with Notes on materials and Processes in Portland Cement Manufacture. Reprinted from *The Engineering Record*. Fully illustrated. Price $3.00. Size 6 in. by 9 in. pp. 235. New York: The Engineering Record.

A series of reprinted illustrated articles. The first, by S. B. Newbery, is a general review of the Portland Cement process. The next eighteen, by various authors, are descriptive of individual American plants; the twentieth deals with the rotary-kiln process; the last three devoted to plants in England and Belgium, Germany and France.

Railway Equipment.

Proceedings of the Western Railway Club. Official Report. Vol. XI. Club Year of 1898-9. 6 in. by 9 in. pp. 416. Vol. XII, Club Year 1899-1900. 6 in. by 9 in. pp. 429. Published by the Western Railway Club, Chicago, Ill., U. S. A.

A full transcript of the proceedings, including addresses, committee reports, papers and discussions. The matters belong almost entirely to the maintenance of equipment department, covering both the mechanical and the transportation problems faced by the master mechanic and master car builder. The discussions are very fully reported and each volume is indexed.

Strength of Materials.

Résistance des Matériaux et Eléments de la Théorie Mathématique de l'Elasticité. By Augustus Föppl. Translated from the German by E. Hahn. Price 15 fr. Size 6 in. by 10 in. pp. 489. Paris: Gauthier-Villars.

A French translation of Föppl's classic work, discussing the fundamental principles of the strength of materials analytically in form for study and reference by the trained engineer. The chapter containing the resume of the mathematical theory of elasticity, according to the modern researches of Boussinesq and Hertz, is especially to be noted. The principal formulas contained in the body of the work are collected as an appendix for greater convenience in practical use.

The Strength of Materials. By J. A. Ewing. Size 6 in. by 9 in. Cambridge: University Press.

A reprint, with many additions and improvements, of Professor Ewing's article on the Strength of Materials in the Ninth Edition of the Encyclopædia Britannica. The work is intended to be used as a text book in connection with drawing office and laboratory work.

Engineering Law.

The Law of Operations Preliminary to Construction in Engineering and Architecture. By John Cassan Wait. Price $5.00. Size 6 in. by 9 in. pp. 638. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Supplementing the author's previous work, "Engineering and Architectural Jurisprudence," and dealing with the knowledge of legal matters essential to the most advantageous conduct of the preliminaries of engineering work, such as rights in real property, boundaries, easements, and franchises.

Logarithms.

An Improved Table of Five-Figure Logarithms. By E. Erskine Scott. Size 4½ in. by 8 in. pp. 66. London: Charles and Edward Layton.

A very convenient small table of five-figure logarithms, especially to be noticed for the arrangement for taking out the differences, these being entered in the table so as to avoid unnecessary computation. The typography has been chosen with especial reference to clearness, and a judicious spacing between the columns also tends to diminish the fatigue of the eyes.

Liquefaction.

The Rise and Development of the Liquefaction of Gases. By Willett L. Hardin, Ph. D. Price, $1.50. Size 5 in. by 7 in. pp. 244. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

A complete history of the development of the methods employed in the liquefaction of gases, with references to the original memoirs of the various investigators.

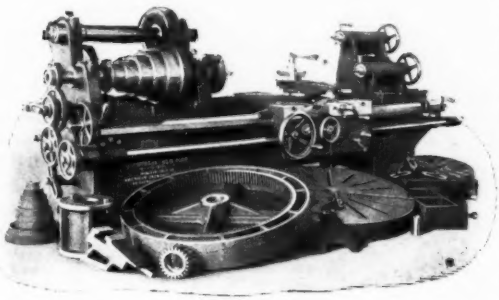
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

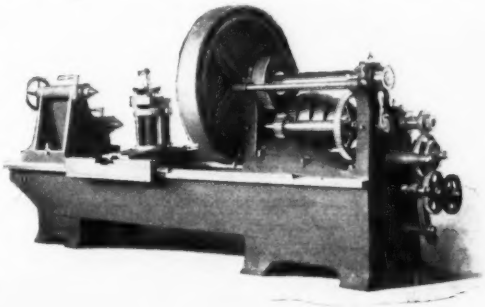
Heavy Two Spindle Lathe.

WE illustrate herewith a new heavy pattern two spindle lathe presenting several interesting features. This lathe is nominally a 26 x 48-inch. It will swing 49 inches over the ways, 45 inches over the wings of the carriage, and will turn 40



inches over the cross-slide. The bed may be made of any length required. With a 12-foot bed it will take 5 feet 8 inches between centers. The bed is wide and heavy, so that neither headstock nor footstock overhang. The support under the footstock end will turn to accommodate itself to an uneven floor, so that there is a three-point bearing for the lathe, and torsion of the bed is avoided. The headstock is made heavy and broad with a steel tie-rod connecting the upper bearings. The headstock is held down by six acce-sible bolts, and there are four internal horizontal screws for lateral adjustment on the bed. The spindle boxes are of hard bronze. The cone has five steps for 3½-inch belt. The lower spindle has the usual back gears, and the upper spindle is connected to it by heavy gears with a ratio of 2 to 1. If a still slower and stronger drive is required, the large face-plate with the internal gear is used, the driving pinion being screwed on to the end of the lower spindle. The spindles are of hammered steel, about 45 points carbon, the lower having a 2⅛-inch hole through it, while the upper spindle is solid. The front bearings are 4¾ x 7 inches, and the rear bearings 3½ x 5¼ inches. The thread of the lead screw is used for screw-cutting only. Pitches from 1 to 2 inches to 31 to 1 inch are cut on the lower spindle with the gears furnished, and double as coarse on the upper spindle. There are three feeds, and by reversing a pair of gears three more, with additional feeds *ad libitum* by change of gears.

The carriage has a bearing 47½ inches long and is gibbed front and back. The cross-slide has sufficient traverse to face without change of tool, the entire swing



diameter of the upper spindle. Quick traverse of the carriage is had by a large hand wheel instead of the usual ball crank. The rack pinion may be thrown out of gear for screw cutting. It has a double bearing so that it will not spring away under heavy work. The feed is reversed in the apron. The half-nuts are opened and closed by the crank handle used for moving the footstock. The same handle will fit also the cross-feed or the compound rest screws and the carriage binder.

The compound rest of the lathe is set at an angle of 30 degrees. There are no projections above the top of the carriage when the cross slide has been removed, except that the cross-feed screw bearing projects a little at the front. This gives an excellent table for bolting work to be bored.

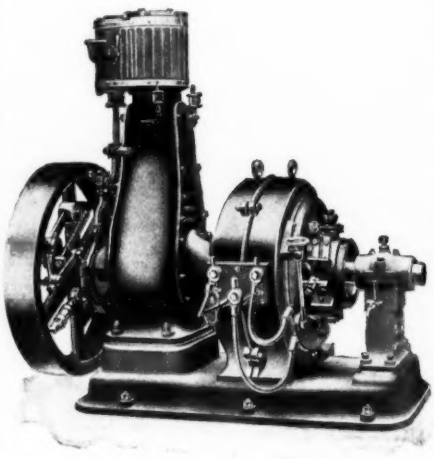
The footstock has a flat bearing 25 inches long and is fitted with a taper gib against the inside of the front of the ways. The barrels carrying the spindles project forward 3½ inches. The spindles are 3¼ inches diameter. The top of the casting provides a neat shelf for tools. The steady rest has an opening of 10½ inches, and a base is provided which brings it in control for the upper spindle when required. The countershaft has one tight and two loose pulleys, the latter being ½ inch less in diameter, and the edges of the tight pulley are well rounded to allow the belt to climb easily. A 4½-inch belt is used. The lathe with 10-foot bed weighs 10,000 pounds. It is built by the American Ordnance Company, Bridgeport, Conn., for J. J. McCabe, 14 Dey street, New York.

Direct Connected Set.

In view of the rapid extension in the use of direct-connected electrical generating sets and the developments which the same have undergone, it is interesting to notice the varying forms which the same take to adapt themselves to different requirements which their service imposes. In those places where floor space is limited or of great value, as it often is in large cities, the compactness of direct connected dynamos with vertical engines is a feature of great utility.

The engraving presented herewith shows the standard Buffalo Forge Company's single vertical engine direct connected to a Lundell dynamo manufactured by the Sprague Electric Co., of New York. Some of the features of direct connected machines illustrated in this set may be of interest.

The engine of the Buffalo Forge Company, Buffalo, N. Y., which is here illustrated and described may of course be connected to any standard type of generator, and for such purpose the cast iron sub-base is varied to conform with the requirements of individual cases. In addition to providing a bed for the engine and dynamo, it likewise carries the outboard bearing, which in this case is of the standard Buffalo adjustable type, ring-oiling and self-aligning. The cast iron frame provides for the guides within, and carries above the cylinder and valve chest. The connecting rod is of forged steel provided at each end with wedge adjusting devices. The crank-shaft, which is large in diameter, is carried in long bearings bolted to the frame. These bearings are provided with an exterior hood or cover which is easily removable to allow for adjustment and to exclude all dust and grit.



The valve, which is of the piston type, governs the steam distribution under the control of a sensitive shaft governor, the

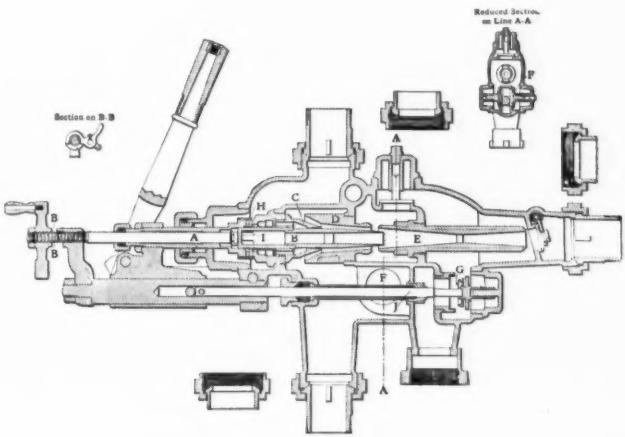
lesign of which makes it easily possible to ecure a very close regulation in speed. It will also be noted that this valve motion gives a constant cut-off at all loads, which s a feature of decided merit under conditions of varying service. Grease and oil ups on all the pins of the governor and alve gear reduce the friction at these parts nd contribute largely to the smooth, steady ction afforded by this valve motion.

The essential particular of lubrication is well provided for in this engine. The well-known automatic system of oiling by means of running the engine with a bath of lubricant in the bed has been most successfully applied to this type of vertical engine, so that the crank-pin, guides and ring-oiling main bearings receive a copious supply of lubricant in this manner. All other bearing surfaces not cared for in this way are furnished with large sight feed oil cups. The removable side plates enclose the working parts so as to afford a dust-proof and oil-tight construction, yet allowing of ready access for adjustment. Careful design, high grade of workmanship and materials, coupled with copious lubrication and close regulation, are some of the essential features of this compact generating set.

The Lunkenheimer '99 Model Injector.

HEREWITH is shown a sectional view of the new injector which the Lunkenheimer Company, of Cincinnati, Ohio, have just placed upon the market. The construction of the machine is novel in a number of particulars and differs essentially from any of those now on the market.

Referring to the cut it will be noted that by pulling the lever slightly the steam valve (*h*) is withdrawn from its seat and steam is admitted to the lifting steam jet (*c*), through the annular space around the movable steam tube (*b*). Steam flowing into water lifting tube (*b*) forms a vacuum in the water supply pipe and the water is "lifted" and passes out through check valve (*a*), also delivery tube (*e*), past the overflow valve (*g*) to the atmosphere. Drawing the handle further back opens the ports (*i, i*) in movable steam tube (*b*), thus admitting steam to the interior of said tube, which forces the water through combining tube (*e*) past line check to boiler, due to the closing of overflow valve (*g*), occasioned by withdrawal of rod (*j*). The principal feature in this machine is that the regulation of the water is accomplished by the movement of the movable steam tube (*b*), the amount of which is controlled by the crank handle at the end of the machine. On this account it differs from all other forms of injectors inasmuch as, in cutting down the discharge of water, the steam consumption is reduced in direct proportion. In all other forms of injectors the



steam supply remains constant, while the water supply alone is reduced.

The manufacturers claim for the injector that it will start promptly under most conditions and can be depended upon to work reliably at all steam pressures from twenty-five to three hundred pounds, and higher. They further claim that it is distinctly a high pressure injector designed particularly for that service. It is also self-adjusting—that is to say, it is not affected by variations of steam pressure, even within great limits, and when started, for instance, at seventy pounds, it can be relied upon to work uninterruptedly to three hundred pounds, and a sudden reduction in steam pressure would not disturb its action. There are a number of mechanical advantages about the injector, such as easiness of making repairs and other details, and the manufacturers will send a complete descriptive circular upon application.

The Introduction of New Manufactures.

If the economical management of works and the reduction in cost of production be considered as of first importance in the manufacture of an article, the economical introduction of the article into the market, together with the dissemination of knowledge concerning it, should be the next consideration.

To most of those who are considering the purchase of new tools or appliances, particularly if they be out of what may be termed the line of staple goods, it is of great advantage to have an opportunity to examine them at leisure, to compare them with similar goods of other makes, to obtain information without being importuned to purchase, and above all to see them in practical operation.

The annoyance to a mill-owner, a salesman, and to a prospective buyer is great, where in order to demonstrate the practical working of a tool the salesman is compelled to ask permission of the mill-owner already possessing one, to bring the buyer—possibly a competitor—into his shop. The mill-owner does not like to refuse, the buyer feels a hesitation about going, and the salesman feels uncomfortable between the two, but is obliged to use all means to effect a sale.

The usual salesroom does not meet all the requirements, inasmuch as there are not different makes of similar machines, they are not in operation and a person must have had his interest previously aroused before going into the salesroom. New tools should be brought before their users in such manner as to excite interest without causing a feeling of liability to purchase.

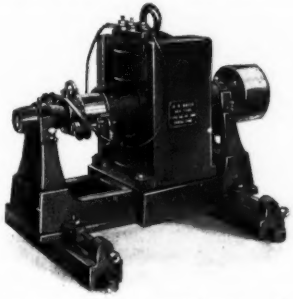
To meet these conditions, and to provide a place where machinery and mechanical appliances can be displayed to the best advantage, the Philadelphia Bourse, through its Exhibition Department, offers a valuable opportunity. Here there are 18,000 square feet for such display, and much of the space is occupied by leading manufacturers. Gas, oil and other engines are shown running side by side, machine tools of all kinds are here, and where desired are in operation. Steam, electric and water power is supplied within reasonable limits. Many of the exhibitors have their representatives on their space, while others arrange jointly for one agent to represent their several non-competing lines. The department is in charge of a competent, practical mechanical engineer of many years' experience, who gives all inquirers such information about exhibits as may be desired, but who is not permitted to express any opinion as to the excellence of one machine over another. Inquiries of all kinds made by mail are answered and the interests of the exhibitors are of course considered in these replies. The exhibits are all dusted, cleaned and cared for by the employees of the department, so that beyond the rental for space and cost of installation there is no further expense.

The Mayer Dynamo.

The cut herewith shows the structural features of the Mayer system of dynamos and motors. This line of machines is notable for extreme simplicity, reducing the number of parts to a minimum, obtaining thus that the machines require but little care and no expert knowledge for their operation.

The frame constituting the whole magnetic circuit is cast in one piece of open-hearth steel, bolted to a substantial cast iron base, which also has the supports for pillow blocks cast with it. These supports are bored out at the same time as the pole

pieces, thus securing perfect alignment. The field-coils are separately wound on well insulated metal spools, which are slipped over and secured on magnet cores. The armatures are of the slotted drum type, finely laminated to avoid heating, and the conductors laid in micanite troughs, are wound to secure perfect electrical and mechanical balance. They have a large carrying capacity so they can stand considerable overload without injury. The commutators, which have large contact and wearing surfaces, are tempered copper, insulated



with sheet mica throughout. Carbon brushes are used in reaction type brush holders and the tension on brushes can be changed at will.

The mechanical construction and material used is of the very best: the details being carefully worked out. The shafts are heavy and run in self-oiling phosphor bronze bearings.

Each machine is carefully tested before shipment, and is provided with a standard size balanced pulley, iron slide rails and automatic underload starting box for motors, and field rheostats for dynamos.

These machines are modern in every respect, being built on the most approved designs, are highly efficient, smooth running, and noiseless. Manufactured by the Maxwell M. Mayer Electric Co., 2363 Second Ave., New York.

Large Westinghouse Transformers.

The rapidly increasing use of polyphase current in power plants of great size is creating a demand for transformers of a larger capacity than have ever before been designed. The Chambly Manufacturing Company has recently placed with the Westinghouse Electric & Manufacturing Company the largest single order for transformers ever recorded.

This order comprises twenty 2,750 K. W. transformers of the Westinghouse air blast type. Each of these, with an output of over 3,600 H. P. of electrical energy, weighs approximately eleven tons and stands nine feet high.

Of the twenty units, ten are used to raise the voltage from 2,200 to 25,000 volts at 8,000 alternations. The input is 2-phase and the output 3-phase. The remaining ten transformers, for lowering the voltage, receive the 3-phase line current at 22,000 volts and deliver out a 2-phase current at 2,400 or 4,800 volts as required.

The blowers for furnishing the air blast for cooling both the raising and lowering transformers are operated by Westinghouse type C induction motors.

The Westinghouse methods of construction are employed in these transformers, both primary and secondary being divided into several flat coils wound with many layers, and few turns per layer, each coil being insulated separately. The advantages of this construction are that it divides the total E. M. F. between the several coils, reducing proportionately the strain of each individual coil; also, it divides the E. M. F. in a single coil between many layers, thus reducing the potential between the adjacent layers. The regulation of the transformers is also improved, and the windings may be connected easily in series or multiple, thus giving a wide range of E. M. F. Also, in case of damage to a coil a substitute may be provided with but little trouble, and without sending the transformer to the works.

Iron and copper have been carefully proportioned to secure the minimum losses, and the efficiency of the transformers is very high, being considerably over 98 per cent.

It is, however, not sufficient that the loss in a transformer be low when it is first installed, for, as is now generally known, much of the iron that has been used in transformers when subjected to the conditions prevailing in continued service is subject to a material deterioration, more or less rapid, with the result of a corresponding material increase in the iron losses. In some cases this increase has amounted to a doubling of the loss found in the trans-

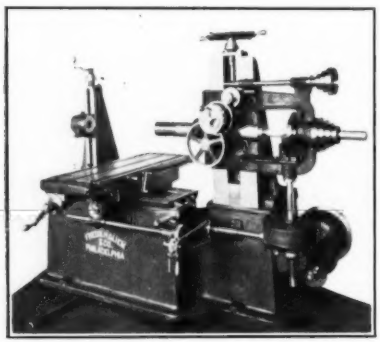
former when first installed. The Westinghouse engineers early discovered this characteristic and at once began a careful and systematic study of the subject, with the ultimate result that there was established a special and thorough process for the manufacture and treatment of transformer iron. Entire success was attained in producing an iron at once capable of high magnetization with comparatively little energy and having a stable character completely resisting the tendency to deteriorate in service with consequently increased losses.

A peculiar feature of these large transformers is the change effected in them from two- to three-phase and from three- to two-phase current, the change being secured by means of special windings, invented by C. F. Scott, of the Westinghouse Company. This greatly increases the flexibility of two- and three-phase methods of transmission.

Gliem Horizontal Boring Machine.

THIS illustration shows a horizontal tool room boring machine, with automatic feed to table. This machine is principally designed for tool room work, and can be used for boring, milling and drilling within its capacity.

The spindle is 2 inches in diameter through the rack sleeve, and has an auto-



matic feed of 16 inches, with four changes, and a rapid hand movement in either direction. The head carrying the spindle has a vertical adjustment of 16 inches. The work table is 16 inches wide and 36 inches long between the pockets, and has an adjustment of 18 inches at right angles to the spindle, and 18 inches parallel with the spindle. The outside support for the boring bar can be easily removed when drilling in the end of long pieces. The adjustments are provided with micrometers reading to thousandths. The machine is strongly geared and well built, and will be found a very useful tool for work within its capacity. These machines are also built without the automatic feed to table, by Fred'k H. Gliem & Co., Philadelphia.

Industrial Notes.

The International Correspondence Schools announce that the great increase in the number of their students has necessitated the opening of Annex No. 6, for the occupancy of the architectural and sanitary engineering schools. A new printing plant, with four and a half acres of floor space, is the next addition to be made.

The Sprague Electric Company has opened another branch office to facilitate the handling of its constantly increasing business in the South. The new office is located in Baltimore, in the Guardian Trust Building, Calvert and German streets, and will enable the company to keep in closer touch with the large amount of government work constantly being done. The manager of the new office is W. H. A. Davidson, who goes there from New York.

The American Bridge Company have grouped all their Eastern plants in one section, and have appointed A. J. Major, formerly manager of the bridge and construction department of the A. & P. Roberts Company, as manager of all of these plants, which include the following: The Pencoyd, East Berlin, Buffalo, Edge Moor, Elmira, Groton, Hilton, Horseheads, Trenton, Post & McCord, Rochester, and the Union plants. Among recent business may be mentioned the contract for a pier and warehouse at Progresso, Yucatan, Mexico, for the Compania del Ferrocarrill, Muelle y Almacenes del Commercio. The pier is to be constructed for a double track railroad, and will be 40 feet wide and 550 feet long; 8 inch solid steel piles will be used. A contract with the crown agents for the colonies of Great Britain to furnish and erect 27 viaducts on the line of the Uganda railway. This will require about 6,000 tons

of steel work. These viaducts consist of plate girder spans on towers, the highest of which will be 112 feet. The steel work, amounting to three thousand tons, for the new Astor building at the corner of Fifty-fifth street and Fifth avenue, New York, and also about two thousand tons of the same class of work for the new Custom House in New York. Two bridges for the New York Central Railroad, and about twenty for the Erie.

The Kempsmith Manufacturing Co. has purchased the business of the Kempsmith Machine Tool Co., and continue the manufacture of the Kempsmith milling machine, at Milwaukee, Wis.

The Keuffel & Esser Co., New York, have established a branch house in San Francisco, at 303 Montgomery street, where they will carry a full stock of their drawing materials and surveying instruments.

The Ashton Valve Co., Boston, have appointed Sidney A. Stephens, of Montreal, Can., agent for the Ashton pop safety valves and steam gauges throughout the Dominion.

The Pittsburgh Gage & Supply Co., Pittsburgh, Pa., report an increasing demand for the Pittsburgh safety water column, particularly from manufacturing plants in Ohio and Michigan. Among the orders received the past month for this appliance are the following from companies who are equipping their plants complete with the Pittsburgh: American Sheet Steel Co., American Steel & Wire Co., Lake Shore & Michigan Southern Railway, American Steel Hoop Co., Crown Fire Clay Co., Structural Steel & Iron Works, Ohio Steel Co., Fleischmann Co., Erhart & Co., Cincinniti Water Works, The Youngstown Steel Co.

The Garry Iron & Steel Roofing Co., Cleveland, Ohio, report that they have just shipped one of their pneumatic cranes to the New York Central Railroad, which makes the fourth pneumatic crane of this type which this road has in use.

The Detroit Graphite Manufacturing Co., Detroit, Mich., in addition to an exceptionally good American business, are doing considerable exporting. They have just filled a large order from Mexico.

Recent export shipments of the Ball Engine Co., Erie, Pa., are: One 40 HP simple engine, and one 75 HP compound direct connected engine to Japan: two 125 HP tandem compound engines to Russia; one 50 HP simple engine to Honolulu, H. I.; one 60 HP direct connected engine to Vera Cruz, Mexico; one 150 HP cross compound engine to British Columbia; one 400 HP direct connected engine to England.

The Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa., has received an order from the government for a quantity of their boiler scale resolvent to be shipped to the United States ice machine, Iloilo, P. I.

A. E. Borie has been appointed general sales agent of the Bethlehem Steel Co., with headquarters at South Bethlehem, Pa.

The Austin Separator Co., Detroit, Mich., have from time to time furnished fifteen separators to the Watkins Salt Co., Watkins, N. Y.

Buff & Buff Manufacturing Co., Boston, announce that they have just moved into extensive additions to their Jamaica Plain shops, which have been fitted up with some of the most accurate special machines and modern machine tools of the present time. Chief among these is a longitudinal dividing machine for graduating on glass ruling fifty thousand to the inch. They have also established a new department for large astronomical instruments for special observatory uses. They still specialize, however, on the "Buff" standard transit for railroad and city triangulation, which is now made in eight sizes, ranging from the transit weighing five lbs. complete to the standard triangulation transit of seventeen lbs.

James Leffel & Co., Springfield, Ohio, report that work is now progressing on a new addition 90 x 220 feet, built of brick and steel and equipped with electrical cranes and a number of new machines, to enable them to supply the growing demand for the Samson wheels. These works will now give work for 300 men. This company has just received an order for a large pair of horizontal wheels from Minneapolis, to develop 3,000 H.P., and another contract for ten 68 inch Samson wheels from Michigan, for driving electrical machinery.

The American Blower Company, Detroit, Mich., manufacturers of hot blast heaters,

fans, blowers, engines, dry kilns, etc., expect to begin operations in the early spring upon extensive additions to their present plant. The plans contemplate a very large addition to the steel plate fan erecting shop, of steel construction throughout. A new blacksmith shop, storage warehouse and power house will be erected. The power house will be equipped with new boilers, engines, dynamos, mechanical draft apparatus, etc., all of the latest design. The entire plant will be remodeled, rearranged and equipped throughout with new cranes, hoists, etc. A commodious and well appointed wash room and locker will be provided for the men.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

CRAIG RIDGWAY & SON CO., Coatesville, Pa.—A very interesting catalogue of balanced steam hydraulic cranes for foundry service, as well as a line of small oil governed air hoists. The illustrations show many interesting installations of both the cranes and hoists.

H. W. JOHNS MFG. CO., New York, N. Y.—A small pamphlet entitled "Exterior Decoration," giving suggestions for shades and trimmings for buildings, together with samples of asbestos liquid paints in attractive colors.

LIDGERWOOD MFG. CO., New York.—A very extensive catalogue illustrating and describing hoisting and conveying machinery employed in the construction of dry docks, dams, canals, piers, walls, fortifications, etc. An interesting feature shown is a self-filling drag bucket used in placer mining.

BETHLEHEM STEEL CO., South Bethlehem, Pa.—A small and very neatly illustrated catalogue showing the works and products of the Bethlehem Steel Co., comprising armor plate, finished guns of all calibers, gun forgings, gun carriages and mounts, and ordnance material of all kinds. Tables are added giving the world's production of pig iron and steel in recent years.

DERBY DESK CO., New York.—Catalogue of expansion business systems illustrating and describing various office appliances built up on the unit system.

INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa.—"General Circular," giving a brief outline of the many courses of study furnished by this school.

WATERBURY ROPE CO., New York.—An interesting catalogue illustrating the manufacture of hemp rope, giving much valuable information with regard to qualities of ropes and their use and preservation.

DAIMLER MFG. CO., Long Island City, N. Y.—A handsome catalogue, in colors, giving details of launches manufactured by this house.

CHAMPION BLOWER & FORGE CO., Lancaster, Pa.—A convenient catalogue of steel forges, lever and crank blowers, blacksmiths' drills, tire benders, and screw plates, taps and dies, fan blowers, exhaust fans, pressure blowers, etc. Much interesting information and many detailed drawings are given.

BOSTON BELTING CO., Boston, Mass.—A strikingly handsome pocket size catalogue of mats, matting, and treads for railways and steamships; with numerous illustrations of special designs in ornamental door mats, cuspidor mats, etc.

H. D. CRIPPEN, New York.—A handy and finely printed catalogue, No. 13, of the Jackson hand power rock drill and equipment, showing general views of the drill, sectional views, and many illustrations of the drill in operation; followed by numerous endorsements from practical miners, and a plate to assist in ordering repair parts by number.

MERWARTH METALLIC GASKET CO., New York.—A neat booklet in colors illustrating the Merwarth metallic gasket consisting of soft metal held in place by a copper ring. Many illustrations of its application are shown.

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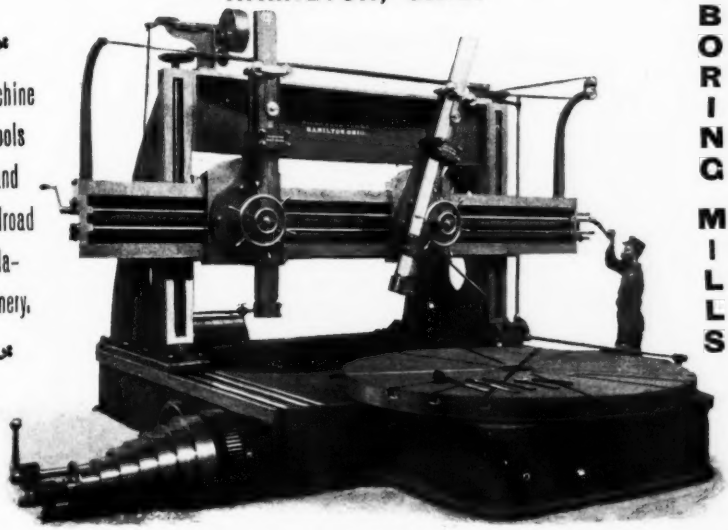

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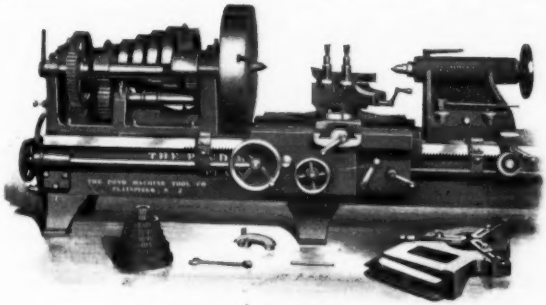

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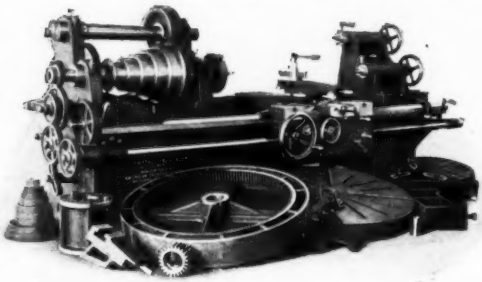

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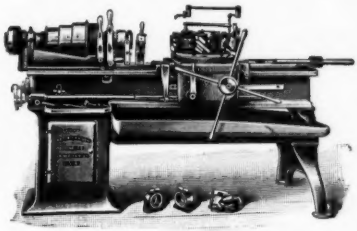

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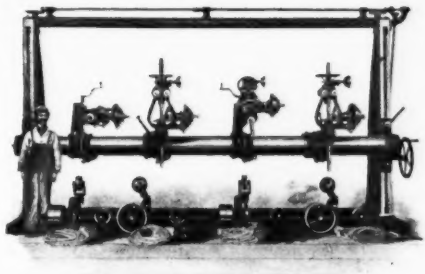

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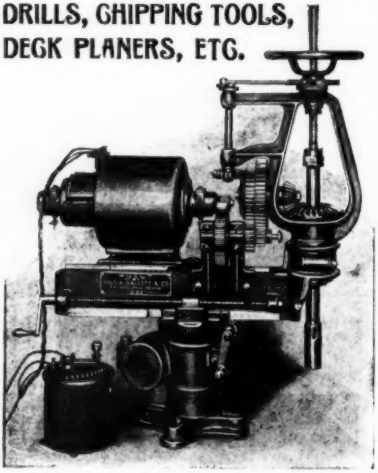

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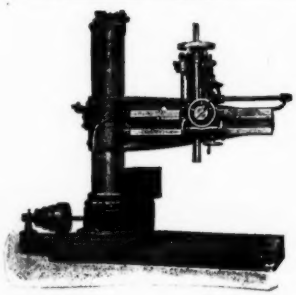

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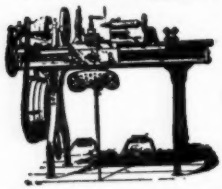

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